BOARD OF COUNTY COMMISSIONERS

INTER-OFFICE MEMORANDUM

To: Honorable Chairman & Members of the Board of County Commissioners

From: Herbert W.A. Thiele, Esq.
County Attorney

Date: January 7, 2005

Subject: TMDL Permit Issues – Workshop on Tuesday, January 11, 2005
Individual Commissioner Updates and Workshop Materials

As you know, the Board of County Commissioners has scheduled a workshop on the afternoon of Tuesday, January 11, 2004, at 3 p.m., to discuss the County's position and to provide direction on future actions by staff and the County Attorney's Office regarding the TMDL permit issues.

The following materials, which were provided to your Commission Aide yesterday, are the materials which will be used at the workshop. Please bring these materials with you to the workshop:

January 5, 2005, letter to City Commissioner Debbie Lightsey, which had the following attachments:

a. January 16, 2005, letter to Ms. Jennifer Eason, Environmental Scientist with the United States Environmental Protection Agency in Atlanta, with attachments. (Copy was also provided to Commissioners when this letter was sent out, with color attachments.)

b. December 21, 2004, letter to Ms. Jennifer Eason, with attachments.

c. December 2004 spiral bound color report from Applied Technology & Management, Inc., (ATM), titled "Nutrient Total Maximum Daily Load for Upper Lake Lafayette, Leon County, Florida).

If you wish to be briefed in advance of the workshop, please contact the County Attorney's Office as soon as possible so that we can schedule an appointment with you for Monday, or for Tuesday morning.

HWAT:mal

cc: Parwez Alam, County Administrator
Gary Johnson, Director of Growth & Environmental Management
Tony Park Director of Public Works
John Kraynak, Director of Environmental Permitting
Theresa Heiker, Stormwater Management Coordinator

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BOARD OF COUNTY COMMISSIONERS

301 South Monroe Street
Tallahassee, Florida 32301
(850) 488-4710

January 5, 2005

Commissioner Debbie Lightsey
Tallahassee City Commission
City Hall
300 South Adams Street
Tallahassee, Florida 32301

Re: *United States Environmental Protection Agency*
Review of TMDL for Upper Lake Lafayette

Dear Commissioner Lightsey:

As you know, the City of Tallahassee and Leon County were both engaged in ongoing discussions with the Florida Department of Environmental Protection with regard to the establishment of a TMDL for the Upper Lake Lafayette and northeast drainage ditch area. However, our staff recently learned that the Department of Environmental Protection has recently transferred its responsibility for developing the TMDL for Upper Lake Lafayette back to the Environmental Protection Agency for Region Four.

In that regard, and in order to provide them with our latest data and position on this matter, the County Attorney's Office has communicated with the Environmental Protection Agency by correspondence dated December 16, 2004 and December 22, 2004. As a courtesy to you and your staff, we are hereby providing you with a copy of the letters and report to the Environmental Protection Agency, along with all attachments, including the ATM December 2004 report.

We are hopeful that the Environmental Protection Agency will promptly take our information into consideration in the final establishment of an appropriate TMDL for Upper Lake Lafayette. Thank you for your continued courtesies and cooperation in seeking a common understanding and amicable resolution of the Upper Lake Lafayette TMDL issue.

Very truly yours,

Cliff Thaell (MTB)

Cliff Thaell, Chairman
Leon County Board of County Commissioners

Attachment

cc: Members of the Board of County Commissioners
Mayor John Marks
Parwez Alam, County Administrator
Anita Favors, City Manager
Herbert W.A. Thiele, Esq., County Attorney
James English, Esq., City Attorney
Tony Park, Director of Public Works
Theresa Heiker, Stormwater Management Coordinator
Gary Johnson, Director of Growth and Environmental Management
John Kraynak, Director of Environmental Compliance

BOARD OF COUNTY COMMISSIONERS

301 South Monroe Street
Tallahassee, Florida 32301
(850) 488-4710

via Federal Express

December 16, 2004

Ms. Jennifer Eason, Environmental Scientist
United States Environmental Protection Agency
Region 4, Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303-3104

Re: *Upper Lake Lafayette and Northeast Drainage Ditch TMDL*

Dear Ms. Eason:

We understand from communications with your staff and with Florida DEP that the responsibility for developing the TMDL for the Upper Lake Lafayette watershed has been transferred from DEP to EPA Region 4. Leon County, Florida has a strong interest in the outcome of this TMDL. We are providing, with this letter and one to follow shortly, significant data and information that we believe are critical for EPA's review.

Upper Lake Lafayette lies within the County's jurisdiction. Much of its watershed and inflowing water, however, lies within the jurisdiction of the City of Tallahassee, where stormwater runoff and sewage leakage is contributing to the deterioration of the lake. The lake continues to be heavily impacted by nutrients, with a large algal bloom and unnatural plant growth surrounding the sinkhole in the northern part of the lake. Over the last few years, the County has actively monitored the quality of the lakes within its jurisdiction and has spent in excess of $10 million remediating the impacts of nutrient and other pollutants flowing into those lakes. Thus, the quality of Upper Lake Lafayette, and of the water flowing into it, is of great importance to the County.

Leon County and the City of Tallahassee both participated in the attempted development of a TMDL by Florida DEP for this watershed, but the stakeholders were not able to reach agreement on the proposed target, the reduction in phosphorus, or the correct way to deal with "phasing" and the implementation of the TMDL. It is our understanding that this disagreement led to Florida DEP's decision to abandon its effort to develop this TMDL and send it to EPA Region 4 instead. The outlines of this dispute are as follows:

The State issued a proposed rulemaking on the TMDL on September 5, 2003. The proposed rule included fecal and total coliform reductions in the Northeast Drainage Ditch (feeding into Upper Lake Lafayette) of 67 and 72 percent, respectively, and a total phosphorus reduction of 39 percent. The City opposed this rule, seeking a "phased" approach under which the TMDL would include very minimal reductions followed by ongoing monitoring. Leon County also opposed the TMDL, but for very different reasons: the reductions were not sufficient to address the serious problems in Upper Lake Lafayette, were not supported by valid calculations and modeling, and were inconsistent with actual monitoring data and other state TMDLs that supported a much more stringent TMDL. The City's efforts were apparently successful, as DEP issued a "Notice of Change" on December 19, 2003, lowering the fecal and total coliform required reductions to 34 and 53 percent, respectively, and reducing the phosphorus reduction to only 165 kg/y. In addition, DEP proposed a "phased" approach under which even these minimal reductions would be imposed only over a five-year period.

Leon County filed a challenge to the DEP rulemaking on January 8, 2004. Thereafter, the stakeholders entered into negotiations in which the County, through the services of Steve Peene of Applied Technologies & Management, provided technical data sufficient to support a significantly more stringent TMDL and otherwise offered its perspective on the proposed approach. As a result of the negotiations and further data submissions, DEP adjusted its coliform reductions upward to 52 and 53 percent, but revised its phosphorus reduction even further downward to only 8 percent. The County objected vigorously to what it viewed as a gutting of the TMDL. As a final settlement position, DEP offered to raise the phosphorus TMDL to 22 percent. The stakeholders were unable to reach agreement, and DEP withdrew its proposed rule on June 25, 2004. The administrative hearing on the TMDL was accordingly closed on June 29, 2004.

The County's position on the Upper Lake Lafayette TMDL during the negotiations is set forth in our most recent two sets of comments on DEP's proposed rules. We have attached these comments as Attachments "A" and "B." They may be summed up as follows:

(1) The target of 0.12 mg/l for total phosphorus is considerably higher than any other comparable TMDL in the state of Florida and is not justified.

(2) The proposed phosphorus reduction of 22 percent is also far lower than most other TMDLs in Florida; is not supported by the monitoring data; and cannot be expected to alleviate the significant algal blooms and other problems in Upper Lake Lafayette;

(3) The State's use of a concentration-based approach to obtain its earlier 8 percent reduction (and the subsequent compromise 22 percent reduction) is erroneous and an improper way of calculating a TMDL for this lake. The correct approach is a load approach, which results in a substantially higher TMDL.

(4) The "phased" approach advocated by the City and adopted by DEP is improper at this stage of the process, during which the State should have established the correct TMDL and not diluted it due to the City's cost concerns. Those concerns should be addressed after the TMDL is promulgated and the stakeholders move to the implementation/BMAP stage of the process.

At the County's request, ATM has calculated the correct TMDLs for the Upper Lake Lafayette watershed, using existing monitoring data and appropriate methodologies. The results of that effort are nearly complete, and the County expects to provide EPA with ATM's report documenting the correct TMDL by Friday of this week. We would urge EPA to consider this report carefully and adopt its conclusions. The County also requests a meeting with EPA personnel at which Mr. Peene can present his findings and answer questions regarding the report and the TMDL issues. We will be in contact with you shortly to arrange such a meeting.

The County very much appreciates EPA taking on this important TMDL and hopes a reasonable approach will result in relatively short order as the lake is in need of immediate attention.

Sincerely yours,

COUNTY ATTORNEY'S OFFICE
LEON COUNTY, FLORIDA

Herbert W.A. Thiele
County Attorney

Enclosures

cc: Honorable Chairman and Members of the Leon County Board of County Commissioners
Parwez Alam, County Administrator, Leon County
Tony Park, Director of Public Works, Leon County
Theresa Heiker, Stormwater Management Coordinator, Leon County
Gary Johnson, Director of Growth & Environmental Management, Leon County
John Kraynak, Director of Environmental Compliance, Leon County
Egide Louis, Environmental Scientist, United States Environmental Protection Agency

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Attachment A
December 16, 2004, Letter to
Ms. Jennifer Eason, Environmental Scientist

BOARD OF COUNTY COMMISSIONERS

301 South Monroe Street
Tallahassee, Florida 32301
(850) 488-4710

April 26, 2004

Commissioners:
WILLIAM C. PROCTOR, JR.
District 1
JANE G. SAULS
District 2
DAN WINCHESTER
District 3
TONY GRIPPA
District 4
BOB RACKLEFF
District 5
RUDY MALOY
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CLIFF THAELL
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PARWEZ ALAM
County Administrator
(850) 488-9962

HERBERT W.A. THIELE
County Attorney
(850) 487-1008

SETTLEMENT CONFIDENTIAL

Mr. Daryll Joyner
TMDL Program Administrator
Division of Water Resource Management
Bureau of Watershed Mgmt., Mail Sta. 3510
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Leon County's Comments on Revised Upper Lake Lafayette and Northeast Drainage Ditch TMDL

Dear Mr. Joyner:

Leon County appreciates DEP's and the City's willingness to engage in stakeholder negotiations to address the issues in this rulemaking. So it could provide meaningful comments on the most recent proposed draft rule, the County needed to review the data provided and discussed during the technical meetings and see what information the City would provide to support its positions. Now that those meetings are completed, and the City apparently does not intend to provide any further support for its proposals, the County is providing these comments on the proposed rule related to nutrients and coliform reduction.

Upper Lake Lafayette continues to be significantly impaired. Recent reconnaissance by Dr. Sean McGlynn has confirmed the presence of large amounts of algae around the sink and excessive hyacinth in many parts of the lake. The condition of the lake must be addressed in the TMDL.

The County believes the revised draft contains some important corrections to the earlier drafts. In particular, DEP has appropriately reinstituted the former coliform limits and eliminated the "interim" TMDLs. The County continues to have significant concerns with the revised rule, however. Most importantly, the 8.4 percent phosphorus concentration reduction identified under the WLA for the Northeast Drainage Ditch is too low to be protective of water quality in the lake. Based on load calculations using the available phosphorus data, the percent reduction within the Northeast Drainage Ditch needed to meet the Total Maxium Daily Load of 1789 kg/year is 54 percent, not 8.4 percent. The 8.4 percent reduction is also derived from a phosphorus target of 0.12 mg/l that is high in relation to other targets used around the State. The identified reduction and target will not sufficiently protect Upper Lake Lafayette from a trophic state index at risk of producing an imbalance in natural populations of aquatic flora or fauna.

The proposed phosphorus target and reduction level are not consistent with similar TMDLs being implemented in Florida. The target established for Upper Lake Lafayette is among the highest in the state. To resolve this dispute short of pursuing the rule challenge, the County would have to see a significant improvement in the numbers that would bring this TMDL more into line with those being developed by DEP elsewhere.

In addition, the proposed rule should establish the TMDL and allocations based on the current record and defer implementation issues for Phase 4. The current record does not contain enough information on the City's proposed plans to justify any modification in the TMDL or allocation. The parties should bring to closure the issues of TMDL calculation and allocation based on the rulemaking record and then turn immediately to the Phase 4 implementation, during which the City should submit information on its management actions and timetables sufficient to permit comment and consideration.

1. The Coliform TMDLs and Reductions

Based upon our examination of the available data, the fecal and total coliform reductions of 52 and 53 percent, respectively, do not appear to be supported by the data, which support a somewhat higher level of reduction around 60 percent. For purposes of settlement discussions, however, the County can accept the revised reductions, assuming they will be vigorously implemented in Phase 4 and assuming the rest of our conditions below are adopted. (The coliform reductions must also be pursued independently of the nutrient reductions.) If monitoring following implementation indicates that the NE Drainage Ditch is still in violation of state water quality requirements, these TMDLs may need to be modified.

2. The Phosphorus TMDL and Reductions[1]

The State has proposed a 1789.9 kg/yr phosphorus TMDL on the basis of an in-flow target for the Northeast Drainage Ditch of 0.12 mg/l phosphorus. The required reduction for waste load allocation and the City's storm water system is proposed at 8.4 percent. The numbers are not justified by the data and are significantly lower than similar TMDLs elsewhere in the State. They will not achieve the statutory goal of eliminating unnatural flora and fauna in Upper Lake Lafayette.

First, the proposed Total Phosphorus (TP) reduction of only 8.4 percent is in error. The reduction percentage calculated using a "load" approach identifies a higher

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1 The County is not addressing the nitrogen TMDL as, based upon analyses to date, it believes phosphorus is the limiting factor in Upper Lake Lafayette and a sufficiently stringent phosphorus TMDL will protect the lake.

necessary reduction. The TMDL is specified as a load (1789 kg/year), thus a loading approach will more accurately reflect the reduction needs, especially in a situation like Upper Lake Lafayette where the bulk of the load comes in during storm conditions. Based on available data, a load-based calculation requires a reduction of 54% to achieve the TMDL of 1789.9 kg/y. At the technical meeting, it appeared that the State's technical personnel were persuaded that a load-based approach is more appropriate. The proposed rule needs to reflect the correct calculation of the phosphorus reduction.

Second, the target and reduction selected by DEP for Upper Lake Lafayette are inconsistent with similar TMDLs elsewhere in the state. Evaluation of TMDLs established for other lakes around the State do not support the proposed 0.12 mg/l target and resultant loading. Targets established for other TMDLs utilize reference watershed conditions where all manmade land use categories (urban, agricultural, low-density residential, medium density residential, high density residential, etc.) were set to inflow concentrations equivalent to forest/rural open with targets ranging from 0.05 mg/L to 0.08 mg/L. The land use associated with a number of these other TMDLs includes significant unimpacted areas, which would be expected to contribute less pollutant to the receiving waters than the area around the Northeast Drainage Ditch. A comparison to these TMDLs would justify a more stringent target for Upper Lake Lafayette inflow, not a less stringent one. Similarly, the reduction percentages for these other TMDLs are considerably higher than the 8.4 percent DEP has proposed for Upper Lake Lafayette, even though the pollution from the Tallahassee urbanized area would likely be higher than these other sites with large open areas.

Data from the other TMDLs argue strongly that DEP should revise the rule to treat Upper Lake Lafayette consistent with the principles it has used in similar waterbodies/watersheds. At a minimum, DEP should revise the load reduction to achieve reductions consistent with those of other TMDLs. The proposed 8.4 percent makes no sense if other sites that are *less* impacted by storm water runoff have higher reductions imposed.

Finally, the issue of uncertainty has been raised repeatedly in the technical meetings, including by City personnel who argue the uncertainty should justify weaker numbers. We do not believe the data is particularly uncertain, and in fact it appears to be comparable to data used to generate TMDLs elsewhere. In any event, the statute requires DEP to include a margin of safety in the TMDLs. The greater the uncertainty in the data, the larger the margin of safety must be to ensure that water quality is achieved. If there is concern over the data, DEP must err on the side of protecting the environment.

We have not seen any justification from the State or the City documenting why Upper Lake Lafayette can absorb a phosphorus level so much higher than any other comparable lake system. A target of this level may well fail to achieve water quality standards in Upper Lake Lafayette and instead convert the lake into a waste discharge facility for the phosphorus contained in the City's storm water system and sewage leaks and overflows.

The County is interested in seeing action taken as soon as possible to begin achieving reductions in the pollutants flowing into Upper Lake Lafayette. To avoid protracted litigation, the County would agree to the 0.12 target, but only on condition that the percent phosphorus reduction be set pursuant to load calculations closer to the 50% level demonstrated by the load calculations, and that the trophic state index and plant life of the lake be carefully monitored to ensure that water quality is being achieved. If the State reverts to the City's proposed concentration-based reductions in the 8 percent range, the rulemaking challenge would likely need to address both the target and the reduction in the rulemaking challenge as inconsistent with other state TMDLs and unlikely to protect the lake's water quality.

3. Deferral of Implementation Issues

As we discussed in our most recent full meeting, the current approach to the rule attempts to address at once all three "baskets" of the TMDL process -- the TMDL calculation, allocation, and implementation. We think this is unnecessary and not justified by the rulemaking record. Phase 4 implementation is an entirely separate process that should occur after the "target" TMDL and basic allocation is established by rule. The rule should not address implementation issues such as two-year timetables and interim coliform reductions. Implementation considerations are not part of the rulemaking process, and there is no record support for these approaches.

(a) DEP should establish the TMDLs without regard to the City's implementation issues.

The statute requires first that DEP calculate the TMDL with regard *solely* to the pollutant reduction necessary to meet water quality standards. Fl. Stat. § 403.067(6)(a). The TMDL is not subject to reduction or moderation based on "implementation" issues such as costs or timetables, which are properly part of allocation and implementation. The TMDLs should not be modified based on what the City believes it can economically achieve. This approach would violate the statute. The proposed coliform and phosphorus reductions must be set according to the available water quality data so that the acceptable loading in the Northeast Drainage Ditch and Upper Lake Lafayette is achieved. The water quality data supports concern for the health of Lake Lafayette and confirms that positive action must be taken now to address storm water impacts.

(b) DEP should establish a preliminary allocation based on the current rulemaking record.

Under the statute, once the TMDL is set based on water quality criteria, DEP is required to establish the wasteload and load allocations by rule. Fl. Stat. § 403.067(6)(b), (d). DEP by law must set the allocations in a manner that will achieve the TMDLs and water quality standards. The allocation *cannot* be varied in a manner that does not attain the standards. *See* § 403.067(6)(b) ("Allocations shall be designed to attain water quality standards . . . ."). The preliminary allocations should be determined as part of this rulemaking process because the statute requires that they be published by rule. § 403.067(6)(d).

The allocations for this rule should prescribe reduction requirements on stormwater management systems fully sufficient to achieve the TMDL. The wasteload allocation thus should establish, at a minimum, a 52 and 53 percent reduction in fecal and total coliform, respectively, and at least a 54 percent reduction in phosphorus, both of which are necessary to achieve water quality standards. Because the State has set the phosphorus target at 0.12 mg/l, however, it is not clear that even a 54 percent reduction will be sufficient. The monitoring program will need to track the lake's trophic state index and plant algae conditions after this reduction is achieved to see if the target should be lowered.

As part of the allocation process, DEP should consider the "eight factors" listed in Section 6(b). In this instance, however, the rulemaking record concerning these factors does not contain any support for altering the allocations. The City has filed comments on the original proposed rule and had numerous additional opportunities to support a modification of the allocation based on these factors. The City's submissions, however, have never proposed or identified any specific factor that would affect DEP's allocation. For instance, in its comments the City argued for the application of the eight factors but never provided DEP with any data or information documenting how or why any of the eight factors would actually apply, or would justify a reduction in the City's allocation. During our last meeting, we requested that the City identify any "moderating provision" that it believed applied, but the City did not do so. We also requested that the City provide specific construction plans and cost information to document its requested allocation reductions, and it has also declined to do so.

We are not insensitive to the potential difficulties in achieving the TMDLs. Implementation issues, however, including the monitoring plan, can and should be considered as part of the Phase 4 B-MAP development after the City provides supporting information during that phase. The record for this rulemaking does not support any modification to the allocation based on the eight factors.

(c) ***Comments regarding implementation in the proposed rule should be modified or removed.***

Some of the comments in the preamble and rule on implementation are not necessary at this time and are not supported by the rulemaking record. Implementation is the province of Phase 4 of the TMDL process. Phase 4 requires submission and development of additional information, including identification of specific management activities, an implementation schedule, and appropriate monitoring and follow up to ensure compliance with the TMDL. *See* "The TMDL Program – Overview of the Basin Management Action Plan Process," Watershed Planning and Coordination Section (Feb. 9, 2004). Specifically, that information should include at least:

- existing management actions that will contribute to the reductions
- proposed management actions designed to restore water quality in these bodies
- estimated pollutant load reduction and the methods and data used to calculate the estimated reduction
- local enforcement ordinances the City plans to enact to implement its actions
- addressing future growth in the City to maintain the TMDL
- criteria the City is using to determine the priority of actions
- public and private partners (e.g., engineers and contractors) who will implement the plan
- an implementation schedule for construction and outcomes
- cost and confirmed sources of funding
- a statement of interim and final targets for evaluation of water quality improvements and the basis for those targets
- a water monitoring and data reporting plan to ensure compliance
- a process for reporting results to the public
- a procedure to be followed if water quality does not improve

Very little, if any, of this information has been developed or submitted to the agency. The City has declined to provide any information on its specific construction plans, costs, timetables, and calculated reduction capabilities. In fact, City officials have clarified that the Stormwater Pollution Reduction Plan provides conceptual level recommendations only which cannot be the basis for any commitment of target reduction. City staff indicated that the implementation of any specific facility may be modified, with potentially reduced treatment capacity, based on public opposition and site constraints.

Thus, the County requests that DEP remove some of the determinations in the preamble that we believe are not supported by the current record. They include:

- *The acknowledgement "that implementation of the TMDLs will be a long-term, phased effort" (p. 1)*. There is no basis in the record for concluding that implementation will be either long-term or phased. This issue will have to be addressed after the City provides the necessary information on its proposed management actions. EPA has made this clear in its Revised 1991 Technical Support Document for Water Quality-Based Toxics Control" guidance: "For a TMDL developed under the phased approach, States should also submit to the EPA a description of the controls to be established, the schedule for data collection, establishment of the control measures, assessment for water quality standards attainment, and additional modeling." As none of this data is currently available, the Department should not now determine that a phased approach for this TMDL is needed.

- *Remove the 12-15 percent reduction in fecal and total coliforms as the interim, two-year goal for the NE Drainage Ditch (p. 2-3).* DEP states that "these reductions in coliform bacteria are the amount projected to occur upon construction and operation of stormwater treatment systems that would be required to implement the nutrient TMDL for the lake." This statement is not supported in the record. Although the City has discussed its "conceptual" plan to install certain storm water ponds, there is insufficient information available to determine whether they will in fact achieve a 12 to 15 percent reduction. The City has not provided the State or County any technical plans for these ponds; sufficient information on their capacity or effectiveness; an implementation timetable; or any verification that the land is available for their construction at the required size.

More importantly, there is no documentation that these unidentified treatment systems are the only feasible means by which the City can reduce coliform over the next two years. We would anticipate, at a minimum, that the City would also institute an extensive sewage monitoring and repair process to prevent the spills and leakage that are likely the largest contributor of coliform and phosphorus to the NE Drainage Ditch. Other actions may also be feasible. Nothing in the current record supports limiting fecal coliform reduction over the next two years to only 15%. The County believes that such a reduction will not protect the public who use the greenways around this water body, and it should not serve as the basis for this rule or limit the City's responsibilities over the next two years.

- *Revise the plan to readopt final TMDLs in five years (pp. 3, 5).* In concept, we are not opposed to the notion that the TMDLs may need to be revisited. This statement needs to be revised, however, to avoid taking the "teeth" out of the TMDL being adopted in this rule. DEP is required to adopt a real TMDL, not a placeholder that will not be enforced for five years. Until data are developed and presented that justify a different approach, the TMDLs established in this rule will be Florida law, and all stakeholders will be required to comply with it.

Following promulgation of the final rule, the County would expect DEP and the City to immediately initiate the Phase 4 B-MAP process to put in place management processes to address the "low-hanging fruit" contemplated by Phase 4, e.g., repairs and monitoring of the City's sewage pipes co-located in the NE Drainage Ditch. If all available interim measures are put in place immediately, a two-year timetable for completing the B-MAP would be reasonable as long as the plan achieved the total TMDL and not just a part of it.

- *Remove the suggestion that a "cooperative study" exists or is underway.* Leon County has not participated in any discussions with the DEP and the City to establish the scope, funding or schedule of a watershed study which could provide data to override the basis for the current TMDL proposed. Thus, we know of no coordinated or cooperative study underway or agreed-to that could form the basis for these comments in the proposed rule. Again, this appears to be directed toward the B-MAP process and is not appropriately included in the TMDL. References to such a study (pp. 3, 5) should be removed and should not form the basis of any rulemaking decision.

If the City continues to insist that it will not settle this dispute without addressing its implementation concerns, then it should supply the information needed for Phase 4 B-MAP development. None of this information is in the current record. It would have to be developed, submitted by the City, and commented on publicly and by Leon County before the rulemaking could move forward. This does not seem to be the process contemplated by the Guidance. In any event, the City cannot simply declare that it will meet the proposed TMDLs without submitting the requisite Phase 4 documentation into the record to support that contention. There is no record on which to base any reduction in the TMDL or change in the allocation, and it would be error to do so.

Attached is a revised draft of the proposed rule reflecting the changes suggested in this letter. We look forward to our next meeting and discussion of these issues.

Sincerely,

COUNTY ATTORNEY'S OFFICE
LEON COUNTY, FLORIDA

Herbert W. A. Thiele, Esq.
County Attorney

cc: Commissioner Cliff Thaell

Parwez Alam, County Administrator
Winston K. Borkowski, Esq., Department of Environmental Protection
Holly Cauley, Esq., Department of Environmental Protection
James S. Alves, Esq.
James English, City Attorney
Edwin A. Steinmeyer, Esq.
Richard Schwartz, Esq.
William Anderson, Esq.

NOTICE OF CHANGE

DEPARTMENT OF ENVIRONMENTAL PROTECTION

DIVISION: Water Resource Management

RULE CHAPTER TITLE:	RULE CHAPTER NO.:
Total Maximum Daily Loads	62-304
RULE TITLE:	RULE NUMBERS:
Scope and Intent	62-304.100
Definitions	62-304.200
St. Marks Basin TMDLs	62-304.300

DOCKET NO.: 03-35R

In accordance with subparagraph 120.54(3)(d)l., Fla. Stat., notice is hereby given that changes have been made to the proposed rules listed above published in the Department's official notice Internet site at www. dep. state. fl. us on September 5, 2003 and December 19, 2003. These changes were made after considering public comments the Department received until the end of the rule hearing and comments submitted to the Department from the Joint Administrative Procedures Committee **[We will need to revise some of this.]**. Specifically, in allocating the proposed total maximum daily loads (TMDLs), the Department considered the availability of treatment technologies, the feasibility of achieving the allocation, reasonable timeframes for implementation, and the extent to which nonattainment of water quality standards is caused by alteration to the water bodies prior to the effective date of Section 403.067, Fla. Stat. These considerations are detailed below.

The TMDLs address the bacteriological impairment in the Northeast Drainage Ditch, an urban stormwater ditch within the Lake Lafayette Drain watershed, and the nutrient impairment in Upper Lake Lafayette. The drain and lake were verified as impaired by fecal and total coliforms, and nutrients, respectively, using the methodology established in Chapter 62-303, Identification of Impaired Surface Waters, Florida Administrative Code, and adopted as impaired by Secretarial Order on August 28, 2002.

The TMDL for the Northeast Drainage Ditch is based on the load duration method and provides the percent reduction in loading to meet the fecal and coliform criteria, based on currently available information about the ditch and coliform loadings in the drain. The TMDL for Upper Lake Lafayette is based on the Reckhow Lake Model and provides the total tributary Total Nitrogen (TN) and Total Phosphorus (TP) loadings that will not exceed an annual average Trophic State Index (TSI) for lakes of 55 for an idealized Upper Lake Lafayette.

Although there are no wastewater facilities authorized to discharge to the drain or lake, both TMDLs include a Wasteload Allocation to address the load from permitted stormwater discharges.

In acknowledgement of the data limitations associated with both the Upper Lake Lafayette and the Northeast Drainage Ditch TMDLs, the Department previously proposed the TMDLs with initial allocations that would allow a phased implementation of the TMDLs. These initial allocations provided for initial pollutant reductions that would make incremental progress towards restoration of these waters while additional data collection and analysis occur. In this current rule, the initial allocations have been removed. The Department is establishing TMDLs for these water bodies that should be achieved as soon as reasonably possible. The existing data is sufficient to promulgate the TMDLs. The specifics of implementation will be determined as part of the development of a Basin Management Action Plan (BMAP) that will address the requirements of Phase 4 of the TMDL process, including the submission of required information on management actions and implementation schedules, providing for additional monitoring of the drain and lake, outlining necessary sanitary surveys (to identify leaking sewer lines, problem septic tanks, and sanitary sewer overflows) and Bacteria Source Tracking techniques to identify sources of coliforms, implementing immediate steps necessary to reduce sewage spills and leakage into the Northeast Drainage Ditch, and identify additional implementation activities and deadlines for the TMDL. This BMAP, which will be developed over the next two years, will, at a minimum, outline activities designed to implement the nutrient TMDL for Upper Lake Lafayette and to achieve the required 52 and 53 percent reductions in fecal and total coliforms, respectively, in the Northeast Drainage Ditch.

If the above steps fail to achieve the water quality in these two water bodies, the Department will revise and readopt new TMDLs as part of the five-year watershed management cycle, which calls for TMDL development for the St. Marks Basin in 2008. PUBLIC COMMENT: Although not required to do so, the Department will accept public comment on the revised proposed rule through April xx, 2004. THE PERSON TO BE CONTACTED REGARDING THE PROPOSED RULE: Daryll Joyner, Division of Water Resource Management, Bureau of Watershed Management, Mail Station 3510, Florida Department of Environmental Protection, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400, telephone (850) 245-8431. THE FULL TEXT OF THE PROPOSED RULE, WITH CHANGES FROM THE NOTICE OF PROPOSED RULEMAKING TRACKED, IS:

CHAPTER 62-304

TOTAL MAXIMUM DAILY LOADS

Part 1. General

62-304.100 Scope and Intent

(1) This chapter establishes Total Maximum Daily Loads (TMDLs), and their allocations, for waters that have been verified to be impaired by a pollutant pursuant to Chapter 62-303, Florida Administrative Code.

(2) This chapter is organized in parts, with parts III through VIII listing adopted TMDLs for waters within each of the six Department district offices. This organization is designed to assist the public in finding specific TMDLs. This organization also tracks the Department's watershed management approach, in which the Department has assigned all of the basins to a specific Department district office. Some basin boundaries overlap more than one district office and readers are encouraged to check sections for adjacent Districts if they cannot find a TMDL for a given water body.

Specific Authority 403.061, 403.067, FS. Law Implemented 403.061, 403.062, 403.067, FS History – New ________________.

Part II. Definitions

62-304.200 Definitions

Total Maximum Daily Loads (TMDLs) shall be defined as set forth in s. 403.031, F.S.

Specific Authority 403.061, 403.067 FS. Law Implemented 403.031, 403.061, 403.062, 403.067 FS. History-New 5-24-01, Repromulgated ___________.

Part III. TMDLs in the Northwest District.

62.304.300 St. Marks Basin TMDLs

(1) Lake Lafayette Drain TMDLs

The Total Maximum Daily Load for coliforms for the Northeast Drainage Ditch within the Lake Lafayette Drain is a 52 percent reduction of fecal coliforms and 53 percent reduction of total coliforms, and is allocated as follows:

(a) The Wasteload Allocation for discharges subject to the Department's National Pollutant Discharge Elimination System Municipal Stormwater Permitting Program is a 52 percent reduction in current fecal coliforms and a 53 percent reduction of total coliforms,

(b) The Load Allocation for nonpoint sources is a 52 percent reduction of fecal coliforms and a 53 percent reduction of total coliforms, and

(c) The Margin of Safety is implicit.

(2) Upper Lake Lafayette TMDLs

(a) The Total Maximum Daily Load for the Upper Lake Lafayette for Total Nitrogen (TN) is 15,725.4 kilograms per year (kg/y), and is allocated as follows:

1. The Wasteload Allocation for discharges subject to the Department's National Pollutant Discharge Elimination System Municipal Stormwater Permitting Program shall be the current TN loading.

2. The Load Allocation for nonpoint sources is 15,725.4 (kg/y) of TN, minus the load that is the responsibility of an NPDES permittee, and

3. The Margin of Safety is implicit.

(b) The Total Maximum Daily Load for the Upper Lake Lafayette for Total Phosphorus (TP) is 1,789.9 kilograms per year kg/y, and is allocated as follows:

1. The Wasteload Allocation for discharges subject to the Department's National Pollutant Discharge Elimination System Municipal Stormwater Permitting Program is a 54 percent reduction in current TP loading,

2. The Load Allocation for nonpoint sources is 1,789.9 kg/y of TP, minus the load that is the responsibility of an NPDES permittee, and

3. The Margin of Safety is implicit.

(3) The Department will revise the TMDL if necessary and through subsequent rulemaking as new research and data become available, but no later than five years from the effective date of this rule. TMDL management activities to achieve the TMDLs shall be

implemented pursuant to the Phase 4 B-MAP process. Specific Authority 403.061, 403.067, FS. Law Implemented 403.061, 403.062, 403.067, FS. History – New ________________.

NAME OF PERSON ORIGINATING PROPOSED RULE: Jerry Brooks, Division of Water Resource Management.

NAME OF SUPERVISOR OR PERSON WHO APPROVED THE PROPOSED RULE: Allan Bedwell, Deputy Secretary, Department of Environmental Protection.

DATE PROPOSED RULE APPROVED BY AGENCY HEAD: February 24, 2003

DATE NOTICE OF PROPOSED RULE DEVELOPMENT PUBLISHED: March 7, 2003

DATE NOTICE OF PROPOSED RULEMAKING PUBLISHED: September 5, 2003

Attachment B
December 16, 2004, Letter to
Ms. Jennifer Eason, Environmental Scientist

BOARD OF COUNTY COMMISSIONERS

301 South Monroe Street
Tallahassee, Florida 32301
(850) 488-4710

June 11, 2004

Commissioners:
WILLIAM C. PROCTOR, JR.
District 1
JANE G. SAULS
District 2
DAN WINCHESTER
District 3
TONY GRIPPA
District 4
BOB RACKLEFF
District 5
RUDY MALOY
At-Large
CLIFF THAELL
At-Large

PARWEZ ALAM
County Administrator
(850) 488-9962

HERBERT W.A. THIELE
County Attorney
(850) 487-1008

Mr. Daryll Joyner
TMDL Program Administrator
Division of Water Resource Management
Bureau of Watershed Mgmt., Mail Sta. 3510
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: Upper Lake Lafayette and Northeast Drainage Ditch TMDL

Dear Mr. Joyner:

Leon County has reviewed the data recalculations you provided to us on May 28, 2004. We appreciate the opportunity to provide comments. Our reactions to the recalculations are as follows:

(1) *The revised reduction is not sufficient to protect the lake.* The revised reduction percentage for phosphorus of 22 percent is an improvement over the most recently proposed reduction of only 8 percent. Nevertheless, the reduction percentage proposed by DEP has been in a steady free-fall since the original proposed rule issued. The changes in the reduction appear to us to be largely in response to pressure from the City based on the City's economic arguments, since DEP has never offered a logical rationale for taking the reduction down to almost zero. Upper Lake Lafayette is significantly impaired, and it is unrealistic to think that a reduction of only 22 percent, no matter how the numbers were developed, will accomplish any genuine improvement in lake quality. The protection of the lake is paramount under the statute.

(2) *The revised reduction continues to rely improperly on a concentration-based methodology.* As to the methodology used, we refer DEP to our previous comments submitted to you on April 26, 2004. In those comments, the County explained the rationale for using load-based calculations rather than concentration-based calculations. The recalculations you have provided continue to rely on the latter, a methodology that DEP has seldom, if ever, used in any other TMDL in the state. We have not seen any rationale from DEP that would justify departure from a load-based approach for this watershed. Your email states, without explanation, only that DEP decided this was the "most reasonable method." The failure to use a load-based methodology is a fundamental flaw in this rule that can only be corrected by applying the correct methodology to the reduction calculation. Load-based calculations demonstrate that the reduction should be considerably higher than 22 percent.

(3) *The phosphorus target is too high.* As we stated in our prior comments, we continue to believe the target of 0.12 mg/l phosphorus in Upper Lake Lafayette is out of line with other TMDLs in the state and will not protect the lake. The recalculations have not modified the target. The data received from the County (your table 3) illustrates that the target is higher than many of the recent storm event readings, when one would expect phosphorus content to be at its highest. A TMDL target set *above* current storm event levels can hardly be expected to alleviate the current impaired condition of the lake.

We appreciate DEP's willingness to work with us and the City during this negotiation period and your providing access to the state's calculations and approach. You suggested an additional meeting, and while we are happy to meet again if you or the City believe a meeting would be fruitful, it is unclear to the County that such another meeting would move the matter forward in light of DEP's unwillingness to correct the fundamental problems in the rule. The County again urges DEP to adopt methodologies and targets consistent with its practice elsewhere in the state and revise the TMDL accordingly. The current proposal does not comply with state law, and the County will likely have to pursue its petition if this version is adopted as the rule.

Sincerely,

OFFICE OF THE COUNTY ATTORNEY
LEON COUNTY, FLORIDA

Herbert W. A. Thiele, Esq.
County Attorney

HWAT:sl

cc: William L. Anderson, Esquire
Edwin A. Steinmeyer, Esquire
Parwez Alam, County Administrator
Gary Johnson, Director of Growth & Environmental Management
Tony Park, Director of Public Works
Winston K. Borkowski, Esquire
Holly Cauley, Esquire

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LEON
FLORIDA'S CAPITAL COUNTY

BOARD OF COUNTY COMMISSIONERS

301 South Monroe Street
Tallahassee, Florida 32301
(850) 488-4710

Via Federal Express

December 21, 2004

Ms. Jennifer Eason, Environmental Scientist
United States Environmental Protection Agency
Region 4, Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303-3104

Re: *Upper Lake Lafayette and Northeast Drainage Ditch TMDL*

Dear Ms. Eason:

Please find enclosed three copies of a report on the proposed TMDL for the Northeast Drainage Ditch and Upper Lake Lafayette, St. Mark's watershed, in Leon County, Florida. Leon County commissioned ATM to produce this report following the withdrawal of the proposed TMDL issued by the Florida Department of Environmental Protection. During the rulemaking, the County had expressed concern that the proposed TMDL departed from the methodology used by DEP for other lakes in Florida and was not sufficient to prevent water quality violations of the nutrient criteria in the lake. The primary problems, illustrated in the graphics attached to this letter, are:

- Upper Lake Lafayette has an episodic elevated Trophic State Index (TSI), with significant exceedances of the Florida threshold of 60 in 1998, 1999, and 2001 (Graphic 1).
- Upper Lake Lafayette has some of the highest total phosphorus measurements in the state for comparable water bodies, with both its 5-year average and the 1998 reading falling within the top three of fifteen such lakes (Graphic 2). These phosphorus levels are contributing to excessive growth of blue-green algae and other nuisance plant species.
- Despite the impaired condition of the lake, the phosphorus target proposed by DEP would have been the highest (weakest) of any comparable lake in the state program (Graphic 3).
- DEP's proposed total phosphorus reduction of 22 percent would also have been one of the lowest (weakest) in the state (Graphic 4).

Because of the disparity between the proposed TMDL for Upper Lake Lafayette and other state lakes, the County opposed the proposed TMDL. When the State withdrew its proposed rule, the County asked ATM to calculate a TMDL for phosphorus consistent with the approaches used by the State elsewhere, with the intention of submitting ATM's TMDL to DEP as the basis for a new rule.

As the ATM report neared completion, we learned that the Lake Lafayette TMDL had been transferred to EPA Region 4 and that DEP no longer had jurisdiction over the TMDL. We are thus transmitting the report to Region 4 instead. Although the report is based on state regulations and practices, we believe it is highly relevant to EPA's analysis and should form the basis for the EPA approach as well. The highlights are as follows:

- This TMDL was developed using FDEP methodology and loading and receiving water models used in other Florida Lakes.
- Because of Upper Lake Lafayette's variability, a critical condition (represented by 1998 data) was chosen in order to ensure that the TMDL was protective of all lake conditions.
- The results of the modeling effort show that a phosphorus target of 0.075 mg/L (equivalent to a 60% reduction) should result in an acceptable TSI below the threshold of 60, indicative of a healthy lake.
- The 60% reduction is consistent with the TMDL reductions in similarly nutrient impaired lakes in Florida.
- Although nitrogen levels are also excessive, it is believed that control of algae blooms through phosphorus reductions may also reduce the nitrogen to acceptable levels. Nitrogen levels will need to be monitored to ensure this is the case.

Upper Lake Lafayette is more than marginally impaired, and the TMDL should reflect a serious effort to reduce phosphorus levels to something the lake can manage. ATM can provide additional information and backup documentation at EPA's request. We also hope to meet with you and your staff shortly to provide further information and discuss the findings in the report. Thank you for your consideration.

Sincerely,

COUNTY ATTORNEY'S OFFICE
LEON COUNTY, FLORIDA

Cherry A Shaw for

Herbert W.A. Thiele
County Attorney

cc: Honorable Chairman and Members of the Leon County Board of County Commissioners
Parwez Alam, County Administrator, Leon County
Tony Park, Director of Public Works, Leon County
Theresa Heiker, Stormwater Management Coordinator, Leon County
Gary Johnson, Director of Growth & Environmental Management, Leon County
John Kraynak, Director of Environmental Compliance, Leon County
Egide Louis, Environmental Scientist, United States Environmental Protection Agency

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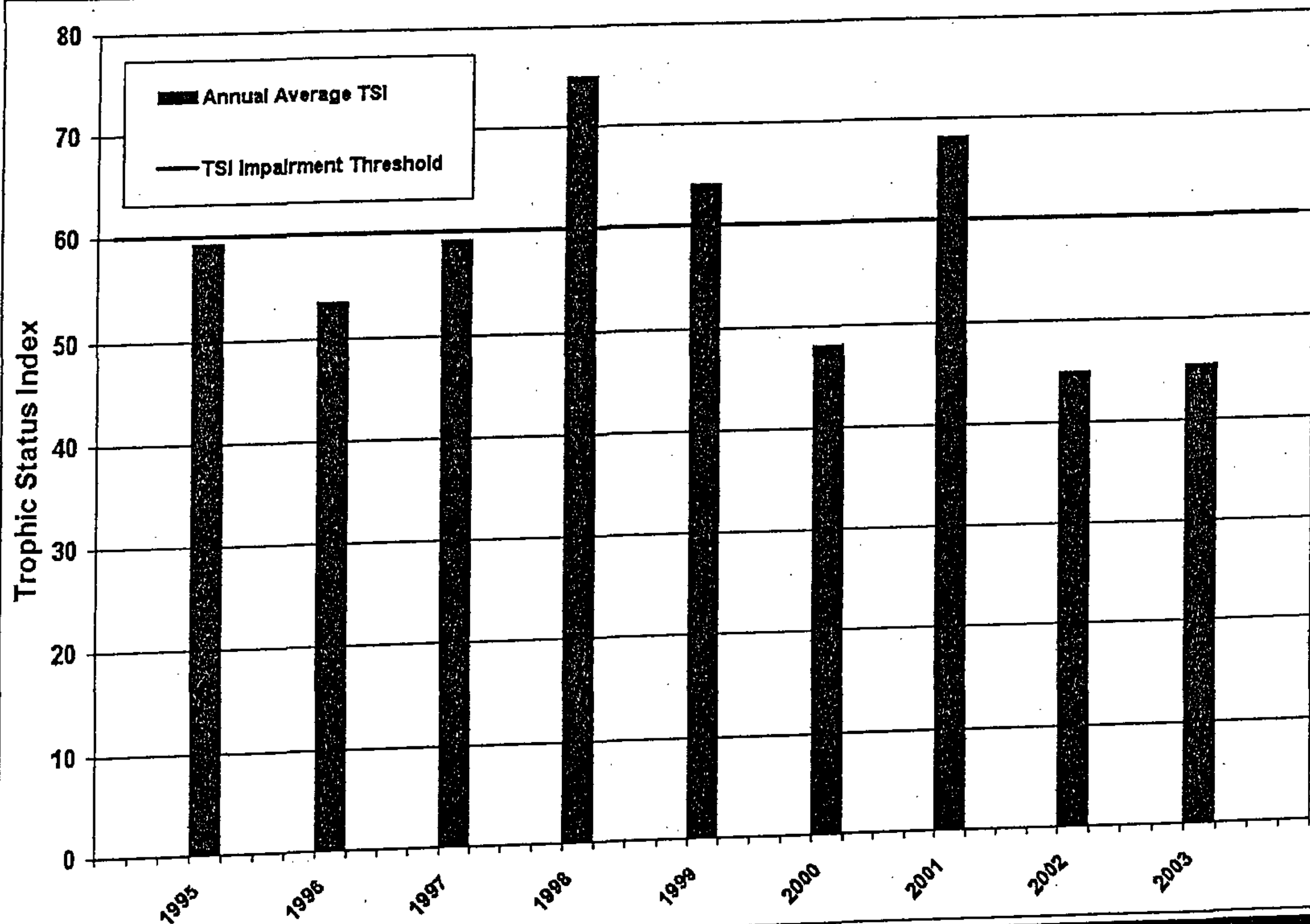
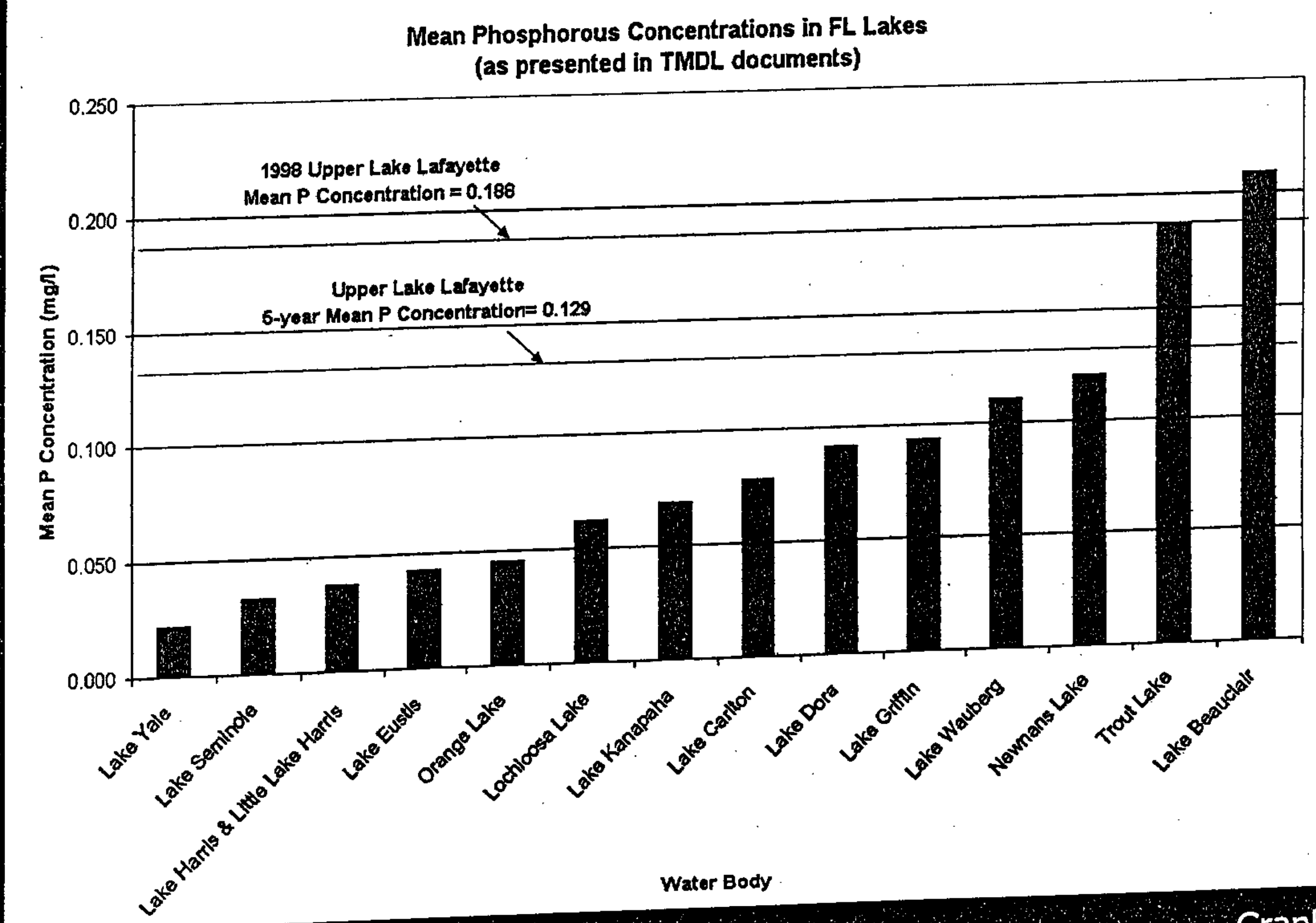
Trophic State Index for Upper Lake Lafayette



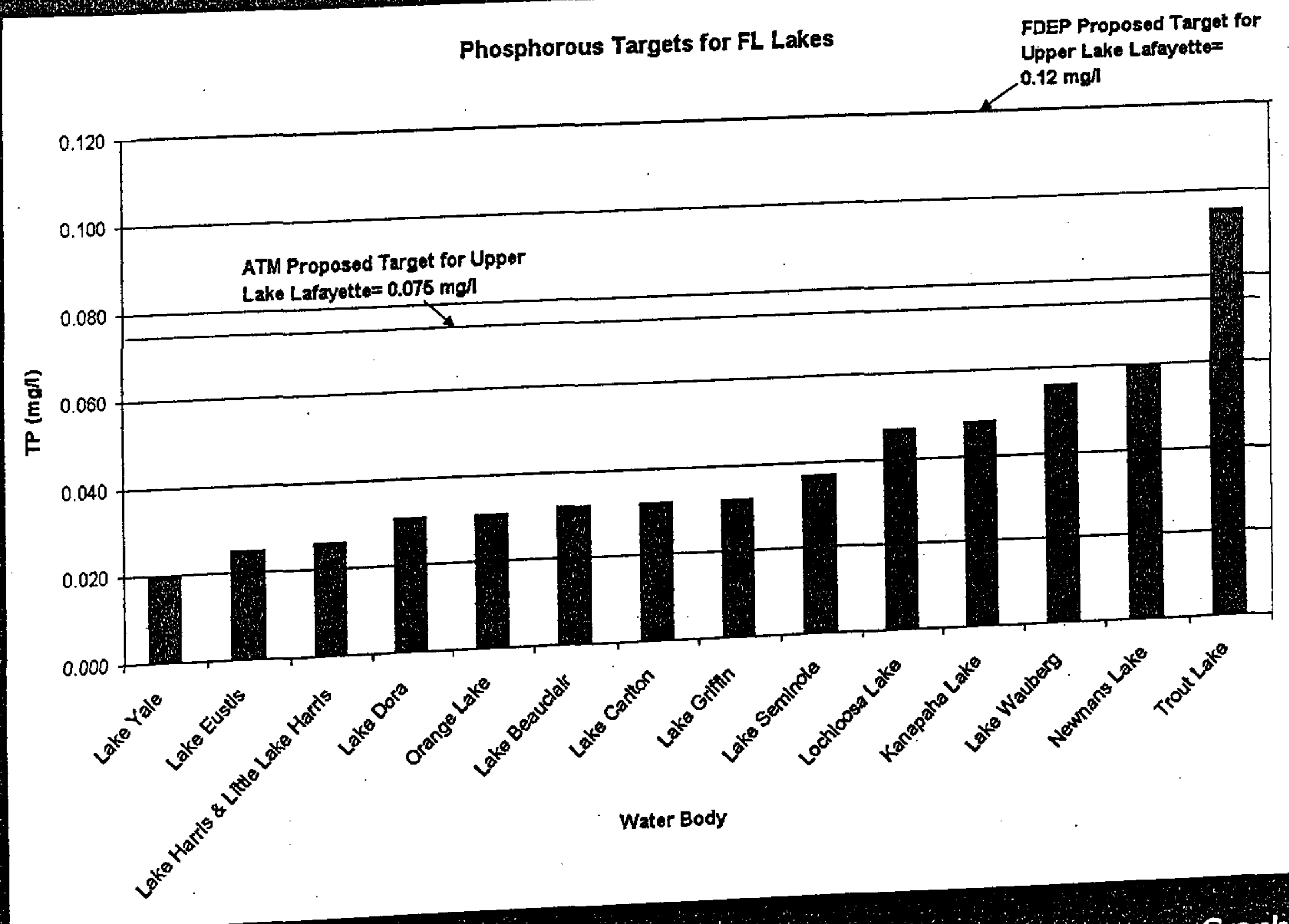
Graphic 1

Phosphorus Levels in Florida Impaired Lakes



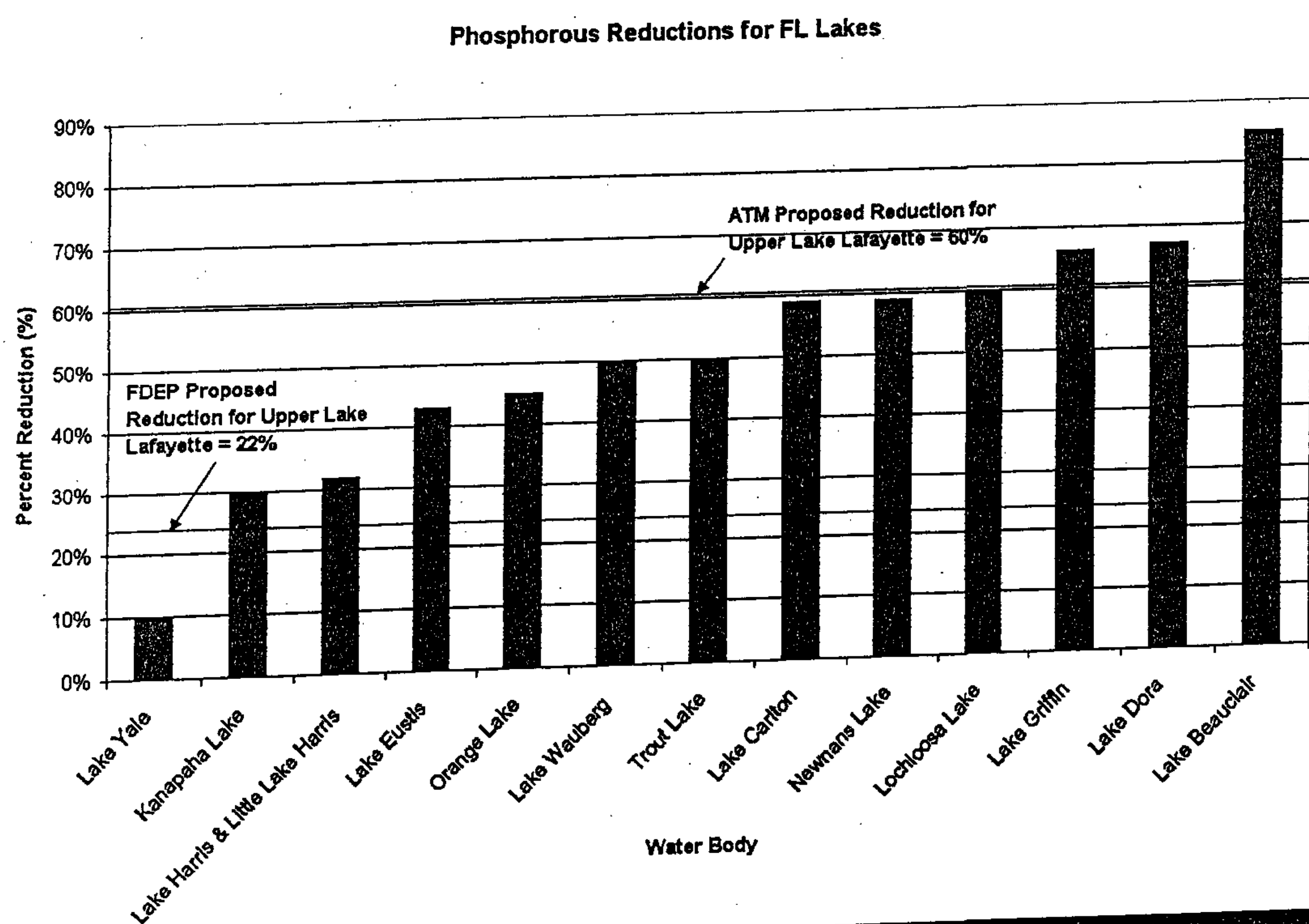
Graphic 2

Phosphorus Targets in Florida Impaired Lakes



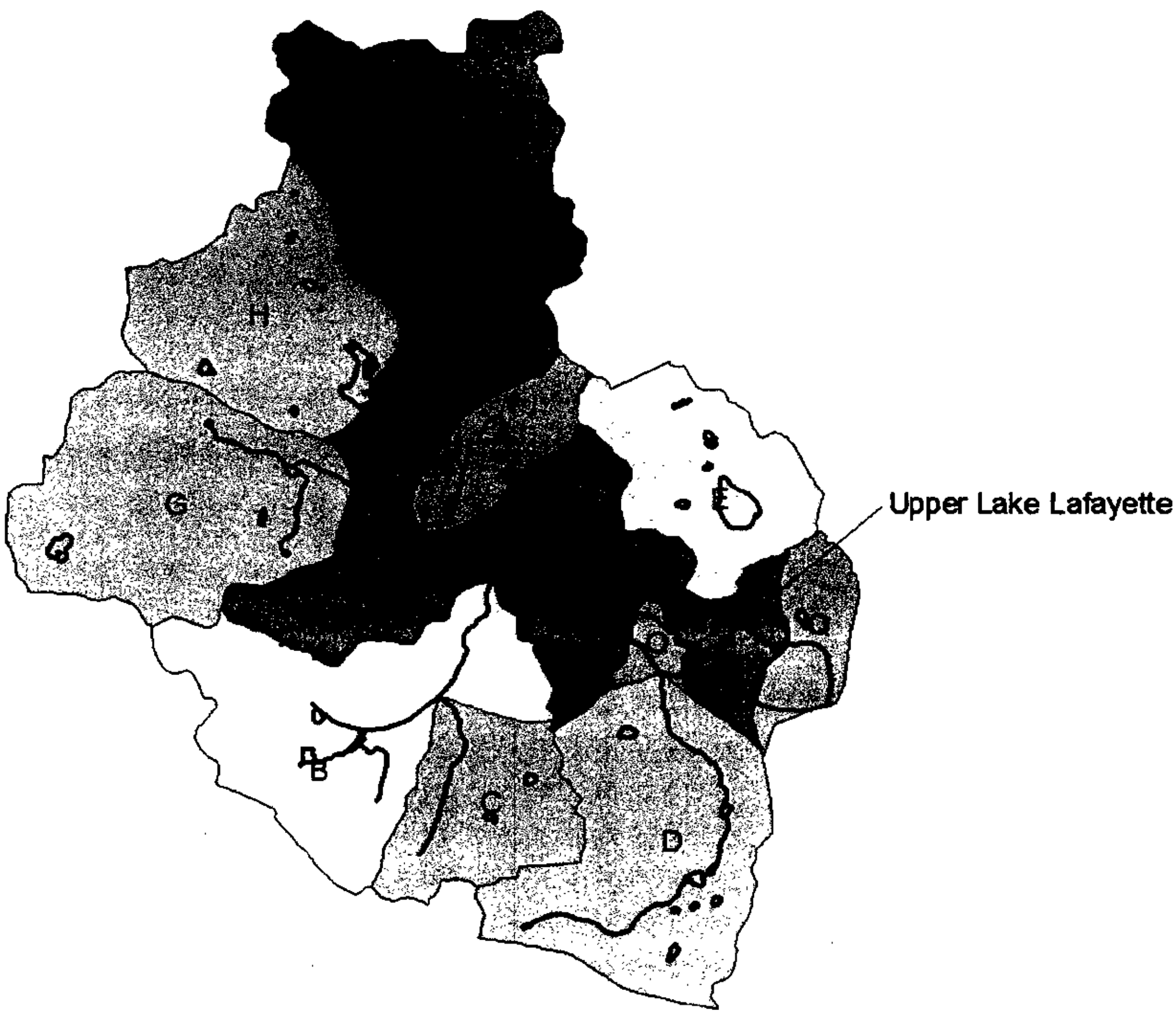
Graphic 3

Phosphorus Reductions in Florida Impaired Lakes



Graphic 4

Nutrient Total Maximum Daily Load for Upper Lake Lafayette, Leon County, Florida



ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC.
2770 NW 43rd Street, Suite B
Gainesville, FL 32606

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December 2004

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1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This report presents the efforts in developing a nutrient TMDL for Upper Lake Lafayette (referred to from this point forward as the "Lake"). The Lake, located in northwest Florida in Tallahassee and Leon County (Figure 1-1), was verified as impaired by nutrients based on elevated levels of the Trophic State Index for lakes, and was included on the verified list of impaired waters for the St. Marks Basin that was adopted by Secretarial Order on August 26, 2002.

According to Section 303(d) of the federal Clean Water Act (CWA) and the Florida Watershed Restoration Act, Chapter 403, Florida Statutes, the Florida Department of Environmental Protection (DEP) is required to submit on a recurring basis lists of surface waters that do not meet applicable water quality standards (impaired waters). The methodologies used by the state for the determination of impairment are established in Rul□ 62-303, Identification of Impaired waters (IWR), Florida Administrative Code (FAC).

Once a water body or water body segment has been verified as impaired and referenced in the Secretarial Order Adopting the Verified List of Impaired Waters, work on establishment of the Total Maximum Daily Load (TMDL) begins. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1999).

This TMDL was developed at the request of Leon County by Applied Technology & Management, Inc. in response to FDEP's withdrawal of a draft TMDL to address nutrient impairment in Upper Lake Lafayette. The TMDL follows FDEP's approach to nutrient TMDLs in other lakes throughout Florida.

1.2 WATERSHED DESCRIPTION

Water movement through the Lake Lafayette system of lakes is very complex. Lake Lafayette Drain, which drains into Upper Lake Lafayette, is made up of four tributaries:

the Northeast Drainage Ditch (NED), Lafayette Creek, a small tributary from the north of the lake, and Lake Piney Z. Of these four, the Northeast Drainage Ditch and Lafayette Creek are the major sources of flow to the lake. The Northeast Drainage Ditch has its headwaters about six miles north of Upper Lake Lafayette and meanders through a highly urbanized section of Tallahassee. Two urban tributaries, McCord Park Ditch and Park Avenue Ditch, join the Northeast Drainage Ditch before its confluence with Upper Lake Lafayette. Lafayette Creek, with its headwaters approximately three miles from the lake, also flows directly into Upper Lake Lafayette. Recent development has made Lafayette Creek a more urbanized system over the past decades.

Land alterations in the mid 1900's separated portions of the Lake Lafayette system. Upper Lake Lafayette is now hydrologically isolated from the rest of Lake Lafayette (McGlynn, 2002). Upper Lake Lafayette contains a large active sinkhole, Lafayette Sink, that drains to the Floridan Aquifer. The area and volume of the lake is highly variable. During typical rainfall periods, the area around Lafayette Sink becomes a 300-acre lake, but following dry periods, such as in August 1999, the lake bed around Lafayette Sink can drain completely.

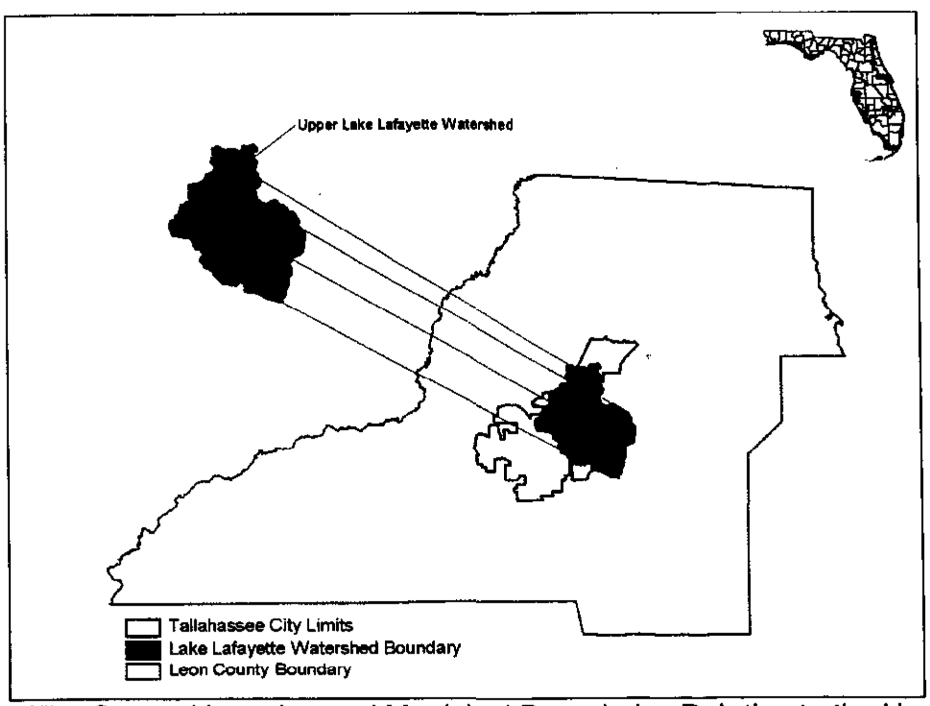

Figure 1-1. The General Location and Municipal Boundaries Relative to the Upper Lake Lafayette Watershed

For assessment purposes, the State of Florida has been divided into waterbody assessment polygons termed Waterbody IDs or WBIDs. Additional information about derivation and use of these WBIDs is provided in the "Documentation For the 2002 Update to the State Of Florida's 303(d) List" dated October 1, 2002, and GIS shapefiles of the WBIDs can be obtained from the following website: http://www.floridadep.org/water/watersheds/basin411/downloads.htm

The Lake Lafayette system is contained in WBID 756, with Upper Lake Lafayette assessed as WBID 756A. See Figure 1-2 for WBID boundaries and the Upper Lake Lafayette watershed boundary that was used in this report for comparison.

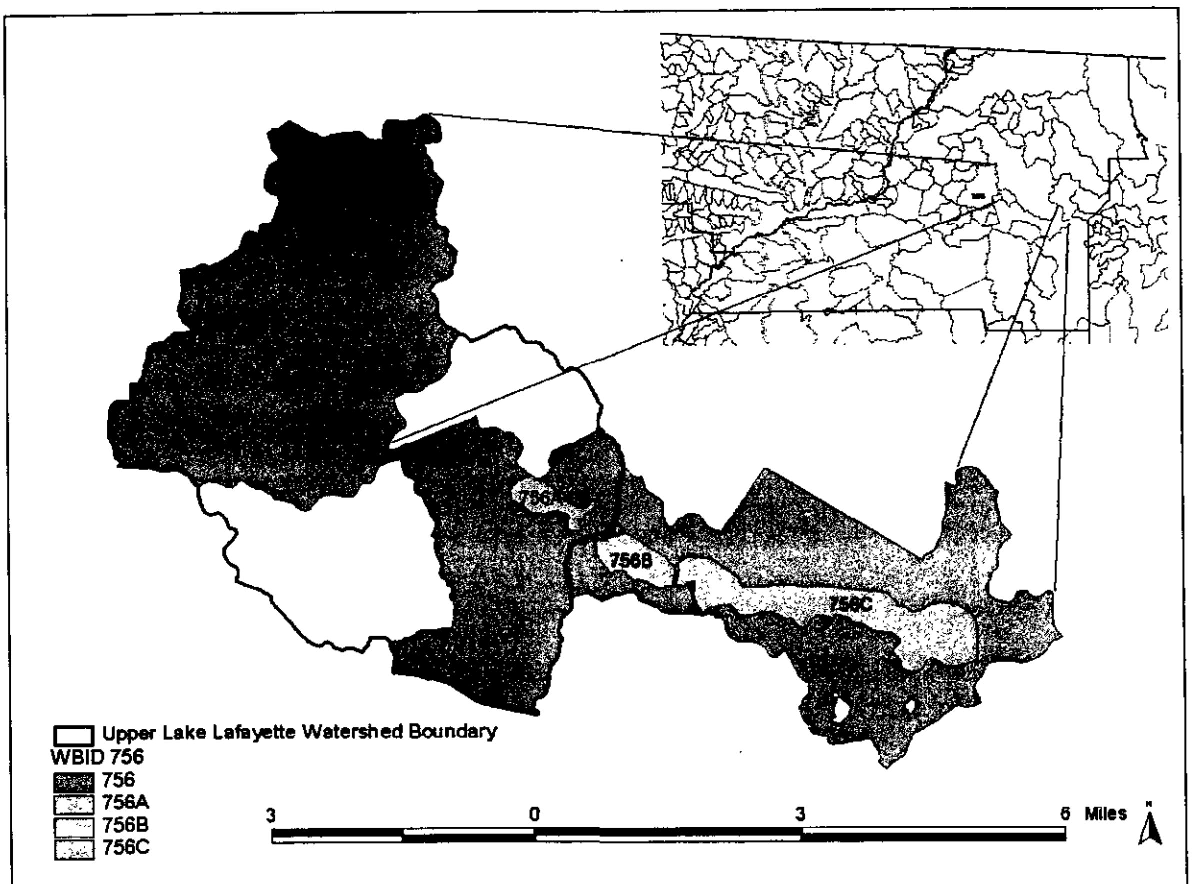

Figure 1-2. The Location of WBID 756 with Leon County Boundary and Upper Lake Lafayette Watershed Boundary for Reference

2.0 DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

Water bodies in the Lake Lafayette Basin portion of the St. Marks River Basin are classified as Class III waters, with a designated use classification for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III water quality criteria applicable to the observed impairment include the dissolved oxygen (DO) criterion (5.0 mg/L), and the narrative nutrient criterion (nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna). Because the nutrient criterion is narrative only, a nutrient related target was needed to represent levels at which imbalance in flora or fauna are expected to occur.

The TSI originally developed by R. E. Carlson (1977) was calculated based on Secchi depth, chlorophyll concentration, and total phosphorus concentration and was used to describe a lake's trophic state. Carlson's TSI was developed based on the assumption that the lakes were all phosphorus limited. In Florida, because the local geology produced a phosphorus rich soil, nitrogen can be the sole or co-limiting factor for phytoplankton population in some lakes. In addition, because of the existence of dark-water lakes in the state, using Secchi depth as an index to represent lake trophic state can produce misleading results. Therefore, the TSI was revised to be based on chlorophyll a, total nitrogen, and total phosphorus concentrations.

The Florida-specific TSI, based on a scale of 0-100, was determined based on the analysis of data from 313 Florida lakes. The index was adjusted so that a chlorophyll a concentration of 20 ug/L was equal to a TSI value of 60. A TSI of 60 was then set as the threshold for nutrient impairment for most lakes (for those with a color higher than 40 platinum cobalt units) because, generally, the phytoplankton may switch to communities dominated by blue-green algae at chlorophyll a levels above 20 ug/L. These blue-green algae are often an unfavorable food source to zooplankton and many other aquatic animals. Some blue-green algae may even produce toxins, which could be harmful to fish and other animals. In addition, excessive growth of phytoplankton and the subsequent death of these algae may consume large quantities of dissolved oxygen and result in anaerobic conditions in lakes, which makes conditions in the impacted lake unfavorable for fish and other wildlife. All of these processes may negatively impact the health and balance of native fauna and flora.

Because of the amazing diversity and productivity of Florida lakes, some lakes have a natural background TSI that is different from 60. In recognition of this natural variation, the IWR allows for the use of a lower TSI (40) in very clear lakes, a higher TSI if paleolimnological data indicate the lake was naturally above 60, and the development of site-specific thresholds that better represent the levels at which nutrient impairment occurs.

A combination of the Watershed Management Model (WMM) and the BATHTUB model was used in this study to estimate the natural background TSI by converting all human land uses (residential, commercial, institutional, industrial, roads/highway) to natural, forested land. This TSI was lower than 60. If the natural background TSI is higher than 60, FDEP has typically planned to use that natural background TSI as a water quality target for the TMDL due to the desire not to abate the natural background condition. Since the natural background TSI is lower than 60, the IWR threshold (a TSI of 60) is established as the target for Upper Lake Lafayette TMDL development.

3.0 STATEMENT OF PROBLEM

Assessment procedures using the IWR database typically base annual TSI values on quarterly weighted average values of TP, TN, and chl-a in years when all of those parameters were sampled during each of the four calendar quarters. Only two years of the verified period (June 1995 - December 2000), 1996 (TSI= 48.27) and 1999 (TSI = 61.04) had sufficient quarterly data in the IWR database to calculate an annual TSI according to the DEP definition.

Calculation of Trophic State Index (TSI)

TSI was calculated using the procedures outlined in Florida's 1996 305(b) report:

$CHLA_{TSI} = 16.8 + 14.4 \times LN\ (CHLA)]$

$TN_{TSI} = 56 + [19.8 \times LN\ (TN)]$

$TN2_{TSI} = 10 \times [5.96 + 2.15 \times LN\ (TN + 0.0001)]$

$TP_{TSI} = [18.6 \times LN\ (TP \times 1000)] - 18.4$

$TP2_{TSI} = 10 \times [2.36 \times LN\ (TP \times 1000) - 2.38]$

Units for TN and TP are [mg/L]. Units for CHLA are [ug/L].

The value of $NUTR_{TSI}$ is dependent upon the N:P ratio:

If $TN/TP > 30$ then $NUTR_{TSI} = TP2_{TSI}$

If $TN/TP < 10$ then $NUTR_{TSI} = TN2_{TSI}$

If $10 < TN/TP < 30$ then $NUTR_{TSI} = (TP_{TSI} + TN_{TSI})/2$

$TSI = (CHLA_{TSI} + NUTR_{TSI})/2$

Based on summaries of the data contained in the DEP IWR Water Run 9.1 database, TSIs were calculated for each quarter and each year in order to see the general trend in TSI values beginning in 1995. As further discussed in Section 5, the TSI was calculated using mean concentrations of total phosphorus (TP), total nitrogen (TN), and chlorophyll a.

The data show that violation of the TSI is not a chronic problem, with average annual TSI values regularly exceeding 60, but an episodic condition associated with high flow events. Upper Lake Lafayette's depth, area, and volume are variable as a function of the rapid runoff from the urban area (FDEP, 2003). The critical condition for nutrient overenrichment in the lake is likely an extended dry period followed by a rain event, when the flow into the lake increases the overall area and volume of the lake to include the lake bed around Lafayette Sink. This condition occurred in 1998 and resulted in a TSI of 74.9. Figure 3-1 shows that the TSI threshold of 60 was exceeded again in 1999 and 2001, but because 2001 is outside of the verified period (June 1995 – December 2000), this year is not considered in this analysis. Algae blooms associated with this condition have been documented in Upper Lake Lafayette – see Figures 3-2 and 3-3 for photographs of algae blooms in 2001 and 2002, respectively. .

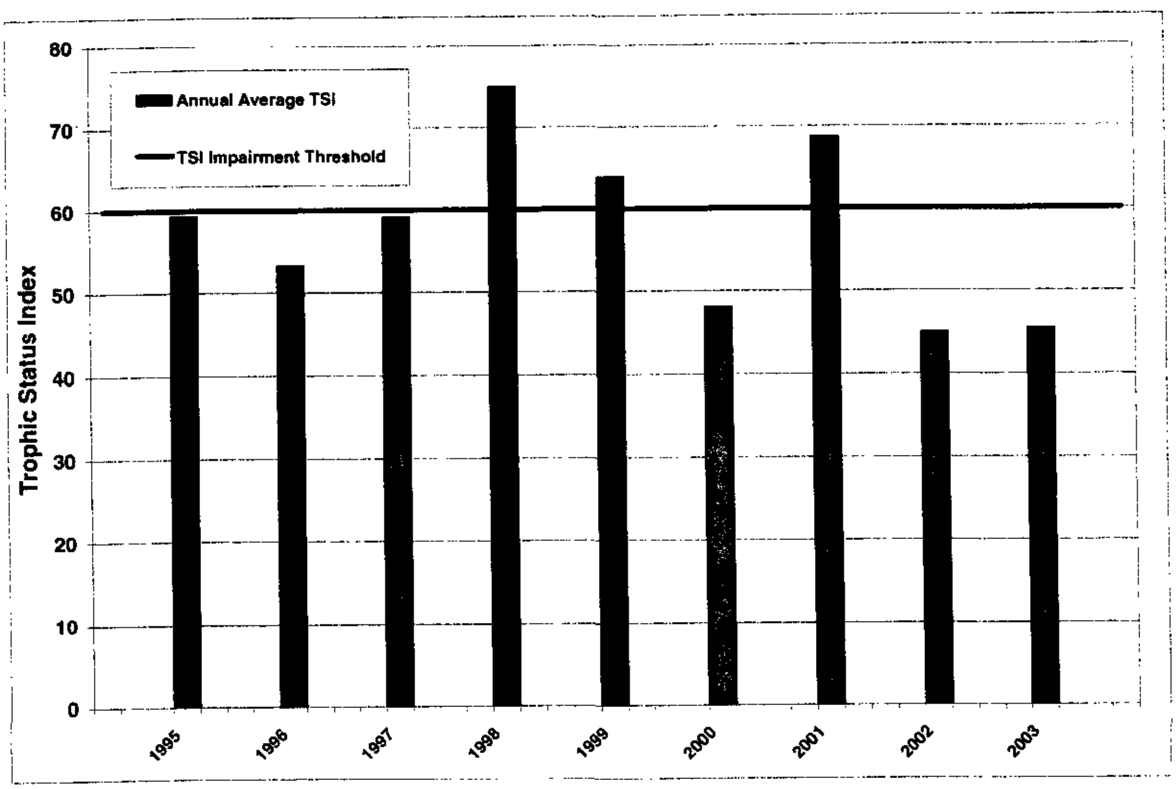

Figure 3-1. Upper Lake Lafayette Annual Average TSI, 1995 - 2003

The draft TMDL for Upper Lake Lafayette describes the impact of high algal productivity on other parameters, such as pH, unionized ammonia, and dissolved oxygen. During this critical condition, when increased flows and increased lake volume follow an extended dry period, the dissolved oxygen percent saturation exceeds the Total Dissolved Gases criterion for Class III waters, which states that dissolved gases should not exceed 150% saturation (FDEP, 2003). Dissolved levels are near zero at the bottom of Lafayette Sink and are supersaturated at the surface (McGlynn, 2002).

To further illustrate nutrient problems in Upper Lake Lafayette relative to other lakes in the vicinity, mean nitrogen and phosphorus concentrations from two non-impacted reference lakes are provided in Table 3-1. Lake Hall and Lake McBride were illustrated in the draft TMDL for Upper Lake Lafayette as maintaining stable TSIs below the threshold of 60 during the recent 10-year period. A comparison of the nutrient concentrations in Upper Lake Lafayette to those of the reference lakes demonstrates the disparity of nutrient overenrichment in Upper Lake Lafayette.

Table 3-1. Background Nutrient Concentrations in Reference Lakes. Upper Lake Lafayette is included for comparison. Source: Draft Nutrient TMDL for Upper Lake Lafayette, FDEP, 2003.

Waterbody Name	TN Mean (mg/L)	TP Mean (mg/L)
Lake Hall	0.38	0.026
Lake McBride	0.74	0.051
Upper Lake Lafayette	1.26	0.133

Because the goal of a TMDL is to protect the subject waterbody, and because Upper Lake Lafayette does not exhibit a chronic nutrient problem with consistent annual exceedances of the TSI threshold as other Florida lakes do, calibrating models to the entire verified period is not applicable. Were this methodology used for Upper Lake Lafayette, the resultant maximum loads would not be protective of the lake during the critical condition as seen in 1998, 1999, and 2001. Instead, a representative critical condition must be identified and simulated in this study in order to ensure that any recommended reductions are protective of this critical condition. This representative condition should reflect the critical period for Upper Lake Lafayette, which consists of an extended dry period followed by increased flow to the lake, resulting in increased volume and area. Increases in in-lake nitrogen and phosphorus concentrations and resultant TSI exceedances of the threshold of 60 occur during this critical period.

1998 exhibited the highest TSI during the verified period (June 1995 – December 2000) (see Figure 3-3). The lake condition during 1998 also fit all of the representative criteria described above – increased flow to the lake followed a period when the lake bed around Lafayette Sink had been dry, resulting in increased lake volume and area. An algae bloom corresponded with measured increases in in-lake nitrogen and phosphorus concentrations (McGlynn 2004, personal comm..). In order to simulate the critical condition for Upper Lake Lafayette, the 1998 data set and lake physical characteristics were used to calibrate the models used in this study.

Figure 3-2. Algae bloom and increased area of Upper Lake Lafayette in August 2001 (Photo: McGlynn Labs)

Figure 3-3. Algae in Upper Lake Lafayette in May 2002 (Photo: McGlynn Labs)

4.0 ASSESSMENT OF SOURCES

4.1 TYPES OF SOURCES

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of nutrients in the Upper Lake Lafayette watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, runoff from agriculture, runoff from silviculture, runoff from mining, discharges from failing septic systems, and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under EPA's National Pollutant Discharge Elimination (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and discharges from a wide variety of industries (see Appendix A for background information about the State and Federal Stormwater Programs).

To be consistent with Clean Water Act (CWA) definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring a NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see Section 6). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 ESTIMATING TN AND TP LOADINGS USING WMM

4.2.1 OVERALL STRATEGY TO DETERMINE LOADINGS AND ASSIMILATIVE CAPACITY

The goal of the nutrient TMDL development for Upper Lake Lafayette is to identify the maximum allowable TP and TN loadings to the lake so that the lake will meet the water quality standard and maintain its function and designated use as a Class III water. Specifically, the goal is interpreted in this study as a TSI of 60.

Three steps were taken to achieve this goal.

1. The Watershed Management Model (WMM) was used to estimate TN and TP loadings from the Upper Lake Lafayette watershed.

2. Resultant loading estimates from the WMM exercise were entered into the BATHTUB eutrophication model to establish the relationship between TN and TP loadings and in-lake TN, TP, and Chl-a concentrations. The model results for in-lake TN, TP, and Chl-a were used to calculate the predicted TSI for several different loading scenarios discussed later in this report.

3. The loadings to the lake were adjusted until the TSI calculated from the model results was less than 60. The TN and TP loadings resulting in a TSI compliant with Section 62-303.450, FAC are considered the nutrient TMDL for Upper Lake Lafayette.

4.2.2 BREAKDOWN OF UPPER LAKE LAFAYETTE WATERSHED AND LAND USE CATEGORIES

The Upper Lake Lafayette watershed drains an area of about 14,962 acres. In order to use the Watershed Management Model to determine the relative loading to Upper Lake Lafayette, the watershed was divided into 13 subwatersheds (Figure 4-1).

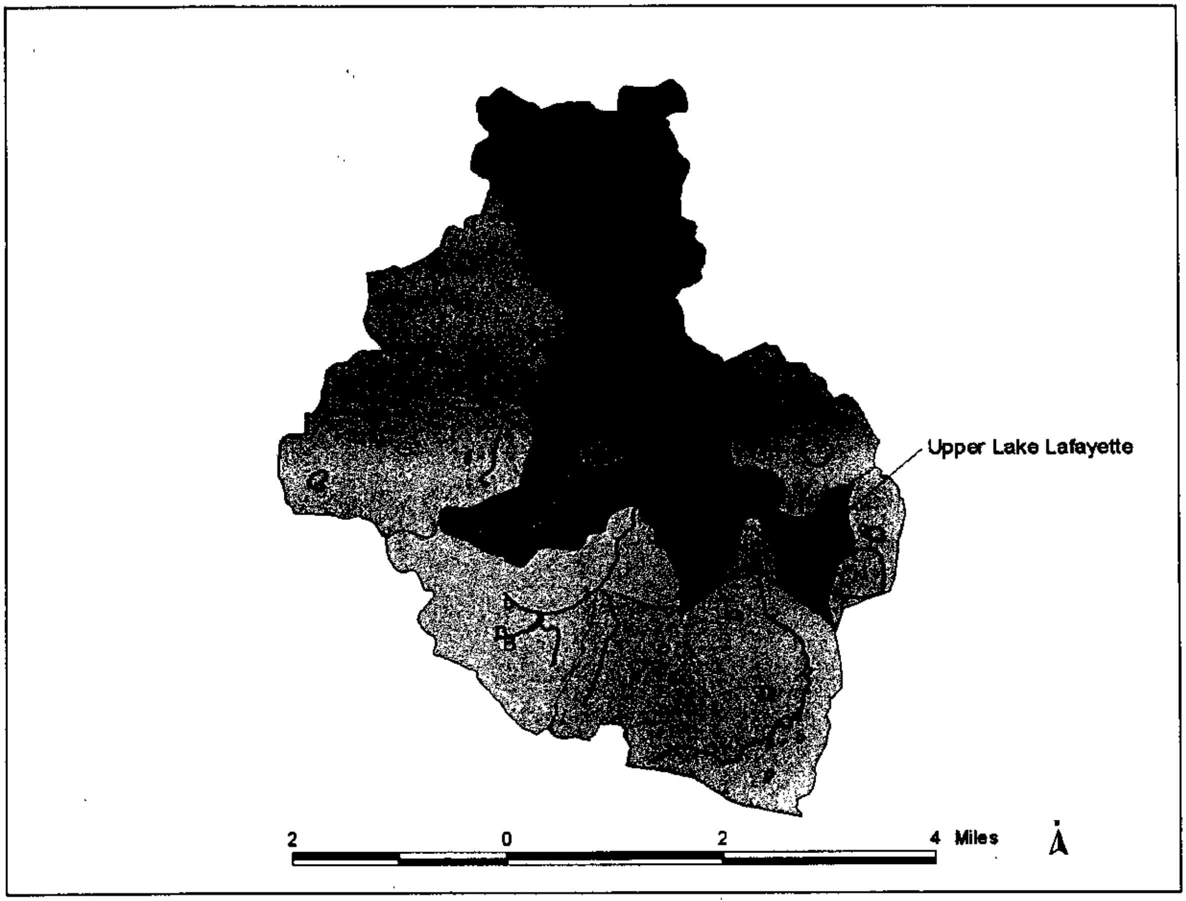

Figure 4-1. Subwatersheds of Upper Lake Lafayette Watershed

Land use categories in Upper Lake Lafayette watershed were aggregated by the Leon County GIS Department. The parcel-specific property use codes from the Leon County Property Appraiser's NAL database were aggregated into twelve broad categories based on criteria used by CDM in the *Blueprint 2000 Capital Cascades Trail Land Use Matrix*. For details on the data processing, see Appendix B.

The spatial distribution of different land use types of Upper Lake Lafayette watershed is demonstrated in Figure 4-2. Detailed maps and tables containing land use data for specific subwatersheds are provided in Section 5.

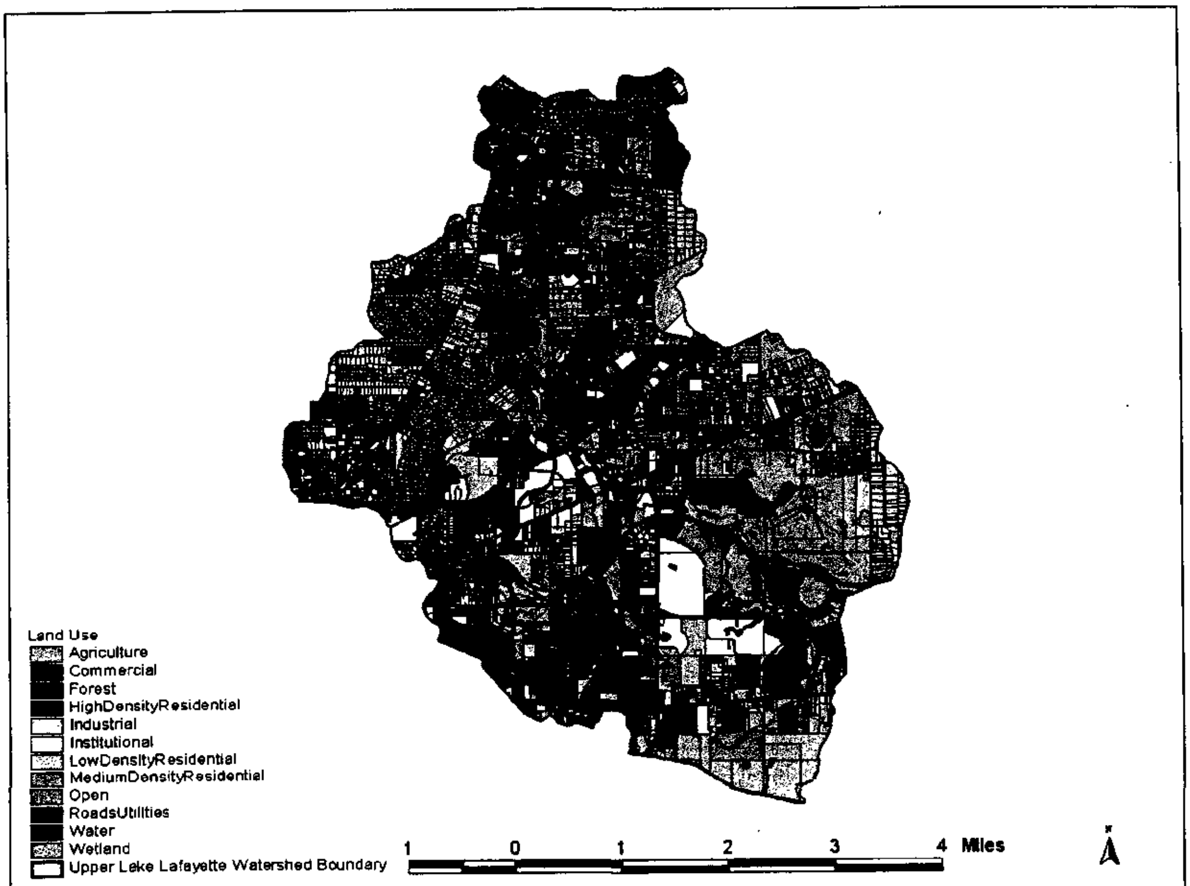

Figure 4-2. Land Use in the Upper Lake Lafayette Watershed

Table 4-1. Land Use Categories and Total Acreage, and Associated Percentage of Each Land Use in the Upper Lake Lafayette Watershed

Land use	Acreage	Percentage of Watershed
Agriculture	1616	10.8
Urban Open	2359	15.8
Low density residential	841	5.6
Medium density residential	1873	12.5
High density residential	2191	14.6
Institutional	878	5.9
Industrial	146	1.0
Commercial	1585	10.6
Roads/Utilities	1951	13.0
Forest/rural open	313	2.1
Water	152	1.0
Wetland	1057	7.1
Total	14962	100

4.2.3 POTENTIAL SOURCES OF TN AND TP IN THE UPPER LAKE LAFAYETTE WATERSHED

Point Sources

While there are permitted wastewater facilities in the contributing drainage area to Upper Lake Lafayette, according to FDEP (FDEP, 2003) these facilities discharge to percolation ponds, sprayfields, or to the groundwater system and there are currently no NPDES wastewater facilities discharging to surface waters in the basin.

The contributing drainage area of the watershed is located within the boundaries of the City of Tallahassee and Leon County Municipal Separate Storm Sewer Systems (MS4s). These systems are permitted under Phase I of the NPDES Stormwater Program.

Nonpoint Sources

TN and TP loadings to Upper Lake Lafayette are generated from sources that are traditionally viewed as nonpoint sources. Nonpoint sources addressed in this study include TN and TP loadings from surface runoff, stream flow, precipitation directly on the surface of the lake, and the contribution from leaking septic tanks. TN and TP loadings through surface runoff were estimated using the Watershed Management Model (WMM) based on the imperviousness and event mean concentration (EMC) of TN and TP from different land use types of the watershed. The spatial distribution and acreage of different land use categories were identified using the land use GIS coverage aggregated to requested specifications by the Leon County GIS Department. Methods used to estimate the TN and TP loadings from stream flow, precipitation directly on the surface of the lake, and the contribution from leaking septic tanks are described in detail in Section 5. TN and TP loadings from ground water and point sources were not considered in this study because previous studies indicated that contribution from these sources are largely insignificant or unknown.

4.2.4 ESTIMATING TN AND TP LOADING FROM THE UPPER LAKE LAFAYETTE WATERSHED USING WMM

The WMM was developed by Camp Dresser and McKee (CDM) under contract to FDEP. The WMM is a watershed model designed to estimate annual or seasonal pollutant loadings from a given watershed and evaluate the effect of watershed management strategies on water quality (WMM User's Manual: 1998). While the strength of the model is its capability to characterize pollutant loadings from nonpoint sources, such as those through stormwater runoff, stream baseflow, and leakage of septic tanks, the model handles point sources such as discharge from wastewater treatment facilities and combined sewer overflows (CSOs) as well. Estimation of pollution load reduction due to partial or full-scale implementation of on-site or regional best management practices (BMP) is also part of the functions of this model. Table 4-2 presents a summary of the WMM data requirements and the sources used for this report.

The fundamental assumption of the model is that the stormwater runoff from any given land use is in direct proportion to annual rainfall and is dictated by the portion of the land use category that is impervious and the runoff coefficients of both pervious and impervious area. The governing equation is:

$$(1)\ R_L = [C_p + (C_I - C_p)\ IMP_L] * I$$

Where:

R_L = total average annual surface runoff from land use L (in/yr);
IMP_L = fractional imperviousness of land use L;
I = long-term average annual precipitation (in/yr);
C_P = pervious area runoff coefficient; and
C_I = impervious area runoff coefficient.

The model estimates pollutant loadings based on nonpoint pollution loading factors (expressed as lbs/ac/yr) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor M_L is computed for each land use L by the following equation:

$$(2)\ M_L = EMC_L * R_L * K$$

Where:

M_L = loading factor for land use L (lbs/ac/yr);
EMC_L = event mean concentration of runoff from land use L (mg/L); EMC varies by land use and pollutant;
R_L = total average annual surface runoff from land use L computed from Equation (1) (in/yr); and
K = 0.2266, a unit conversion constant.

Table 4-2. Summary of WMM Data Requirements and Sources

Data Type	Data	Generic Source	Data Source for Lake Lafayette Modeling
Watershed Characteristics	Drainage Area	USGS Quadrangle Maps; Local Topographic Maps; Local GIS	FDEP WBID GIS Coverage, USGS Quadrangle Map, Hydrographic GIS Coverage
	Existing Land Use	Aerial Photography; Land Use Maps; LandSat Imagery; Comprehensive Land Use Plans; Large Development Plans; Zoning Maps	Leon County GIS
	Topography / Soils	USGS Quadrangle Maps; SCS Soil Surveys	USGS Quadrangle Map STATSGO GIS files
Rainfall / Runoff	Long Term Average Annual Precipitation	NWS Weather Stations	NOAA National Data Center Precipitation Data for Tallahassee Regional Airport
	Annual Streamflow	USGS Monitoring Gages	USGS Stream flow data for gages in WBID 756, NWFWMD Data, FDEP Data
	Impervious Cover	Aerial Photos; (large scale) "Typical" Site Plans	Calculated in the WMM using land use data
Watershed Water Quality Data	Storm Event Mean Concentrations	NPDES Permit Applications; USEPA NURP Study (1983); FHWA (1990); NURP Project Final Reports; State, Local Pollution Control Dept.	Leon County NPDES Permit Application, City of Tallahassee, Literature Values
	Baseflow Concentrations (Ambient Water Quality)	USEPA STORET WQ database; State, Local Pollution Control Dept.	IWR Database; USGS NAWQA Data through 9/30/2002; FDOT Data, STORET
	Monitoring Data	Local WWTP/Utility; State Agency; USEPA	IWR Database, USGS, FDOT Data, STORET
	Inventory of Package Plants, Industrial Dischargers	Utility Location Maps; Local WWTP/Utility; State Agency; USEPA	FDEP NPDES GIS Coverage

Calibration of the WMM is usually conducted on both runoff quantity and quality. This is a two-step procedure since the water quality calibration is a function of the predicted runoff volumes. Calibration of water quantity is usually achieved through adjusting the pervious and impervious area runoff coefficients. Typical ranges of runoff coefficients are 0.05 – 0.30 for pervious area (WMM User's Manual: 1998) and 0.85 – 1.0 for impervious area (Linsley and Franziani, 1979). After the water quantity calibration, water quality is calibrated by adjusting the pollutant delivery ratio, i.e., the percent quantity of pollutant in the surface runoff that is eventually delivered to the destination waterbody. In this effort, the range of the pollutant delivery ratio was estimated using the method developed by Roehl (1962) that correlates the delivery ratio to watershed area.

4.3 ESTABLISHING THE RELATIONSHIP BETWEEN TN AND TP LOADING AND IN-LAKE TN, TP, AND CHL-A CONCENTRATIONS USING THE BATHTUB MODEL

BATHTUB Eutrophication Model

The BATHTUB eutrophication model is a suite of empirically derived steady state models developed by the U. S. Army Corps of Engineering (USACE) Waterways Experimental Station. The primary function of these models is to estimate nutrient concentrations and algal biomass resulting from different patterns of nutrient loadings. The procedures for selection of the appropriate model for a particular lake are described in the Users Manual. The empirical prediction of lake eutrophication using this approach typically can be described as a two-stage procedure using the following two categories of models (Walker 1999):

- Nutrient balance model. This type of model relates in-lake nutrient concentration to external nutrient loadings, morphometry, and hydrology.

- Eutrophication response model. This type of model describes relationships among eutrophication indicators within the lake, including nutrient levels, Chl-a, transparency, and hypolimnetic oxygen depletion.

The nutrient balance model adopted by BATHTUB assumes that the net accumulation of nutrients in a lake is the difference between nutrient loadings into the lake from various sources and the nutrients carried out through outflow and losses of nutrient through whatever decay process occur inside lake:

(3) Net accumulation = Inflow – Outflow – Decay

In this study, "inflow" included stormwater surface runoff from various land use categories, leakage of septic tanks, and direct atmospheric precipitation into the lake. Nutrient outflow was primarily through the seepage of the sinkhole system. To address nutrient decay within the lake, BATHTUB provided several alternative mass balance models depending on the inorganic/organic nutrient partitioning coefficient and reaction kinetics. The major pathway of decay for TN and TP in the model is through sedimentation to the bottom of the lake.

Prediction of the eutrophication response by BATHTUB also involves choosing between several alternative models depending on whether the algal communities are limited by phosphorus or nitrogen, or co-limited by both nutrients. Scenarios that include algal communities limited by light intensity or controlled by the lake flushing rate are also included in the suit of models. In addition, the response of chlorophyll a concentration to the in-lake nutrient level is characterized by two different kinetic processes: linear or exponential. The variety of models available in BATHTUB allows the user to choose specific models based on the particular condition of the project lake.

One feature offered by BATHTUB is the "calibration factor." The empirical models implemented in BATHTUB are mathematical generalizations about lake behavior. When applied to data from a particular reservoir, measured data may differ from predictions by a factor of two or more. Such differences reflect data limitations (measurement or estimation errors in the average inflow and outflow concentrations), unique features of the particular lake (Walker 1999), and unexpected processes inherent to the lake. The calibration factor offered by BATHTUB provides model users with a tool to calibrate the magnitude of lake response predicted by the empirical models. The model calibrated to current conditions against measured data from the lake can then be applied to predict changes in lake conditions likely to result from specific management scenarios under the condition that the calibration factor remains constant for all prediction scenarios.

Data Required for Calibrating the BATHTUB Eutrophication Model

The relationship between TN and TP loading and the in-lake TN and TP concentrations was established through fitting the BATHTUB predictions with the measured TN and TP concentrations of the lake. To calibrate the model, the following data were required:

1. Physical characteristics of the lake (surface area, mean depth, and mixed layer depth)

2. Meteorological data (precipitation and evaporation)

3. Measured water quality data (TN, TP, and Chl-a concentrations of the lake water)

4. Loading data (flow and TN and TP concentrations of the flow from all point and nonpoint sources)

The BATHTUB model also allows both error and variability analysis. Whenever model inputs were calculated from historical time-varying data, long-term average and coefficient of variance (CV) of the average were determined for the input.

Error and Variability Analysis

The distinction between "error" and "variability" is important. Error refers to a difference between a measured and a predicted mean value and is usually described as:

The absolute value of |measurement – prediction|/measurement. Variability refers to spatial or temporal fluctuations in measurement around the mean. Spatial variability is not usually included in the variability analysis of empirical modeling efforts. Empirical modeling variability analysis usually concentrates on those changes caused by temporal fluctuation. Variability is frequently described using the mean coefficient of variance (CV), which is defined as the standard error (SE) of the estimate expressed as a fraction of the predicted value (Walker 1999). In this study, model estimates were presented as mean ± 1SE whenever a CV could be determined.

When WMM was used to simulate TN and TP loadings from surface runoff, only error analysis was conducted. The variability analysis within WMM required CVs for the EMC of TN and TP from different land use categories and the CV for the suspended fraction of TN and TP from different land use categories. Because we did not have these CVs, the variability analysis was not conducted using WMM. WMM simulation was conducted for the identified critical condition represented in1998. Model predictions for all the years were later averaged to calculate the long-term annual mean and CV, which are required for the error and variability analysis for BATHTUB.

BATHTUB allows the input of the CV for both measured data and model predictions from WMM. To accomplish this, several years of measured data from the non-model variables (precipitation, lake volume, and evaporation) and the WMM predictions (TN, TP, and flow) were averaged and the mean values and CVs of these data were entered to BATHTUB as input.

4.4 TMDL DEVELOPMENT FOR UPPER LAKE LAFAYETTE

Once WMM and BATHTUB model calibrations were achieved, the TMDL of the lake was developed through evaluating TSIs of the following scenarios:

A. TSI of current condition

B. TSI after the loadings from all human land use categories (urban open, low, medium, and high density residential, agriculture and rangeland, and transportation, communication, and utilities) within the watershed were assessed as the land use category Forest/Rural Open. This is the watershed Natural Background condition

C. TSI after all the loadings from human land use categories were assessed as natural background

The scenario C was considered the natural background condition of the lake. If the TSI of scenario C was lower than 60, the loadings from human land use would be allowed to increase and up to the final TSI of 60. If the TSI of Scenario C were higher than 60, then the Natural Background TSI would become the target for the TSI.

Requirement for Historical Data and Overall Data Availability

Model calibration and simulation of this study requires that several types of data should have measured historical record. These data types and their availability are listed in Table 4-3.

Table 4-3. Data Types with Historical Data and Available Time Periods

Data type	Available time period
Precipitation	1993 – 2004
Stream flow (multiple stations)	1990 –2000
Lake stage	Not available
Tributary water quality data	1995 – 2000
Lake water quality data	1995-2000

Because calibration of the model requires that data from the different types be in the same time period, and 1998 was the worst year in terms of the calculated TSI value, 1998 was chosen as the year from which data were used for model calibration.

5.0 RESULTS

5.1 DATA ANALYSIS

Historical Trend of Upper Lake Lafayette Trophic Status

Monthly TN, TP, and chlorophyll a (chl a) concentrations from Upper Lake Lafayette (WBID 756A) were retrieved from the IWR database. The individual station from which water quality data were collected is shown in Figure 5-1 and is known by a variety of station IDs: 21FLA 22030046, FDEP 858, and 21FLMCGLLCL-L02. This station is located in the sinkhole portion of Upper Lake Lafayette.

Quarterly mean values for TN, TP, and chl a concentrations were calculated based on available monthly data values. Quarterly TSIs were calculated based on the quarterly mean values of TN, TP, and chl a concentrations. Annual mean TSI values were then calculated using the quarterly weighted average TN, TP, and chl-a concentrations. The 1995-2003 annual mean TSI values are presented in Table 5-1.

Table 5-1. 1995 – 2003 Quarterly Weighted Annual Average Nutrient Values and TSI for Upper Lake Lafayette

Year	Chl (ug/L)	TN (mg/L)	TP (mg/L)	TSI
1995	26.82	0.856	0.055	59.3
1996	16.43	0.629	0.126	53.4
1997	19.05	0.968	0.149	59.1
1998	59.93	1.959	0.188	74.9
1999	18.17	1.828	0.122	64.0
2000	7.91	0.626	0.113	48.1
2001	48.16	1.278	0.176	68.7
2002	5.27	0.619	0.139	45.0
2003	10.62	0.406	0.060	45.5

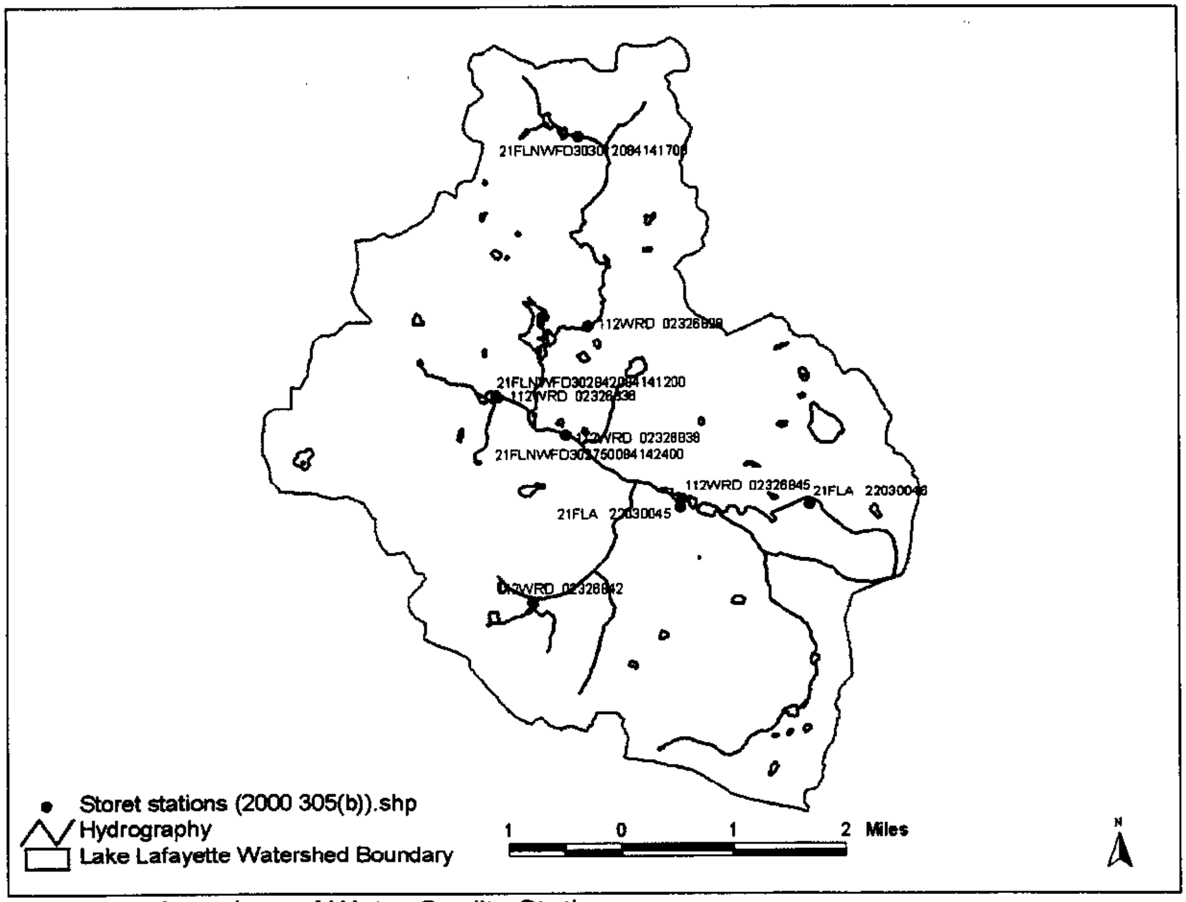

Figure 5-1. Locations of Water Quality Stations

5.2 DATA REQUIRED FOR ESTIMATING TN AND TP LOADINGS FROM CONTRIBUTING SUB-BASINS USING WMM

The following data are needed in order to use WMM and are described in detail in the following sections:

- Precipitation data
- Land use categories
- Percent impervious area
- Event Mean Concentration (EMC) data
- Percent of nitrogen and phosphorus in dissolved form
- Sediment delivery ratio
- Septic tank failure loading rate
- Subwatershed loading

5.2.1 PRECIPITATION DATA

Precipitation data were collected from one weather station in the proximity of Upper Lake Lafayette, located at the Tallahassee Municipal Airport (Figure 5-2). Precipitation data from this weather station include data representing 1995-2000.

Table 5-2. Annual precipitation at Tallahassee Municipal Airport

Year	Annual Precipitation (in/year)
1995	52.4
1996	53.24
1997	64.25
1998	58.83
1999	50.07
2000	44.51

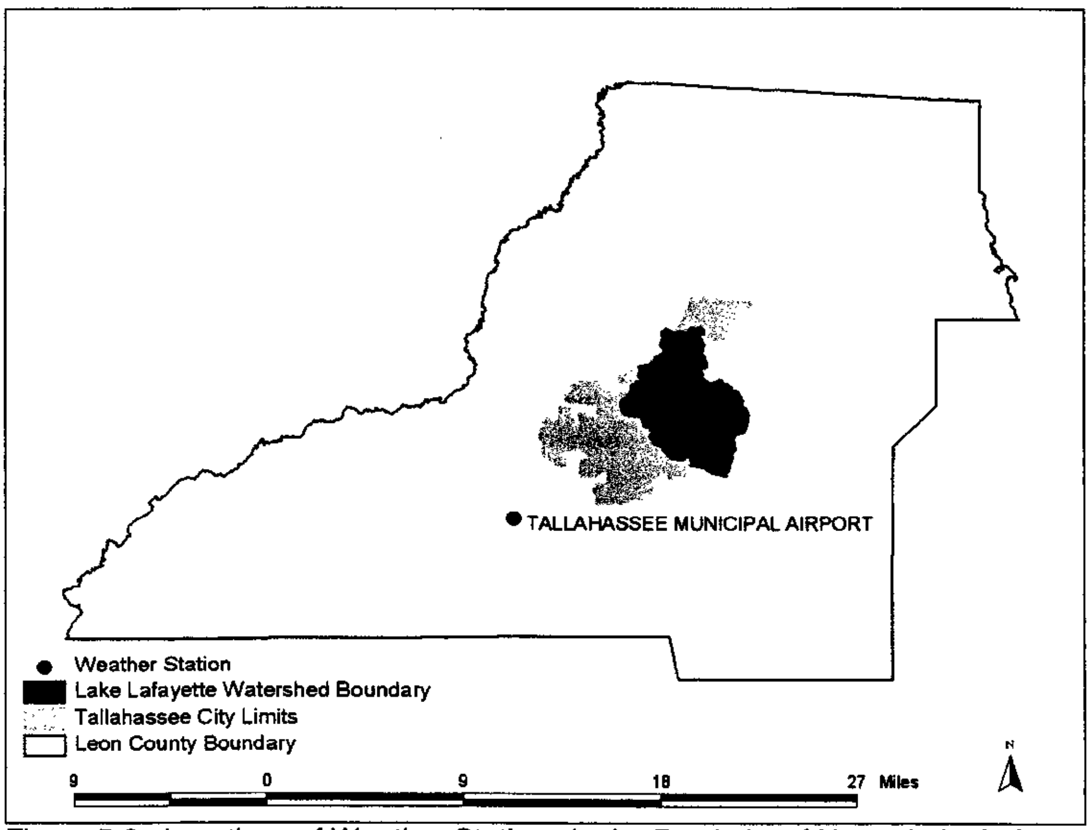

Figure 5-2. Locations of Weather Stations in the Proximity of Upper Lake Lafayette. Boundaries of Tallahassee and Leon County are shown for reference.

5.2.2 LAND USE CATEGORIES

Land use categories in Upper Lake Lafayette watershed were aggregated by the Leon County GIS Department. The parcel-specific property use codes from the Leon County Property Appraiser's NAL database were aggregated into twelve broad categories based on criteria used by CDM in the *Blueprint 2000 Capital Cascades Trail Land Use Matrix.* For details on the data processing, see Appendix B.

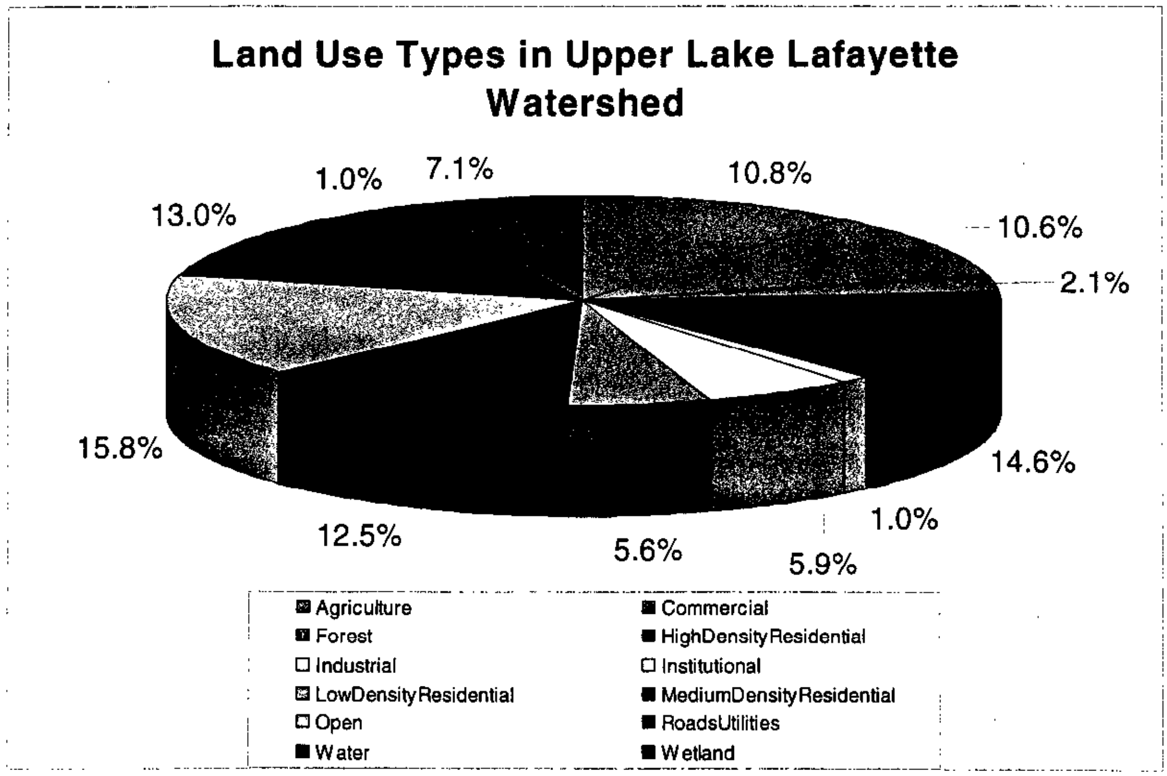

Figure 5-3. Percent Distributions of Each Land Use Category in Upper Lake Lafayette Watershed

Human land use categories, or the above categories excluding Water, Wetland, Open, and Forest land use designations, account for about 74% of the total acreage of the Upper Lake Lafayette watershed, suggesting a significant influence from human activities on the land use pattern of the watershed and the overall quality of the Lake Lafayette resource. The leading human land use category in the Upper Lake Lafayette watershed is High Density Residential.

Figures 5-4 through 5-16 present the land use distribution by subwatershed. Tables 5-3 through 5-15 present the acreage and percentage of the subwatershed associated with each land use category.

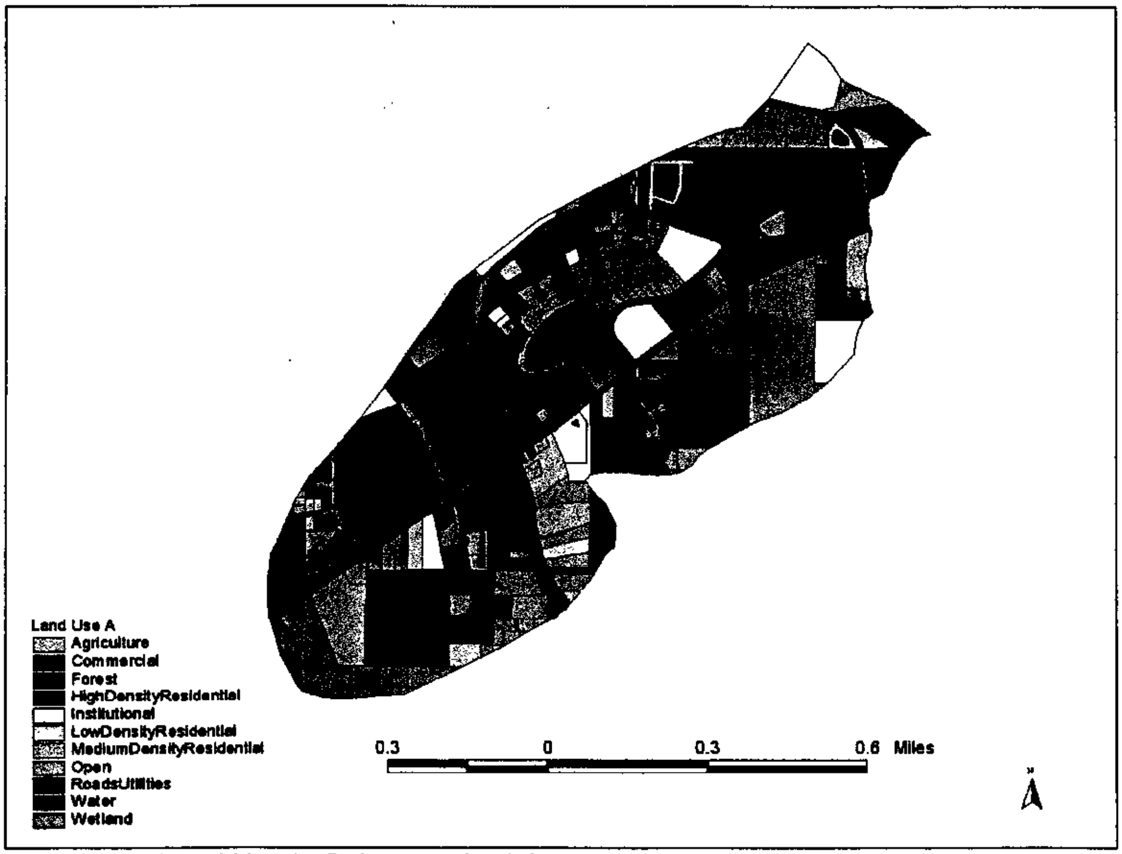

Figure 5-4. Land Use in Subwatershed A.

Table 5-3. Land Use categories in Subbasin A.

Land use	Acreage	Percentage of Watershed
Agriculture	20	4.4
Urban Open	96	21.1
Low density residential	6	1.3
Medium density residential	12	2.6
High density residential	132	29.1
Institutional	32	7.0
Industrial	0	0.0
Commercial	88	19.4
Roads/Utilities	50	11.0
Forest/rural open	5	1.1
Water/Wetland	13	2.9
Total	454	100

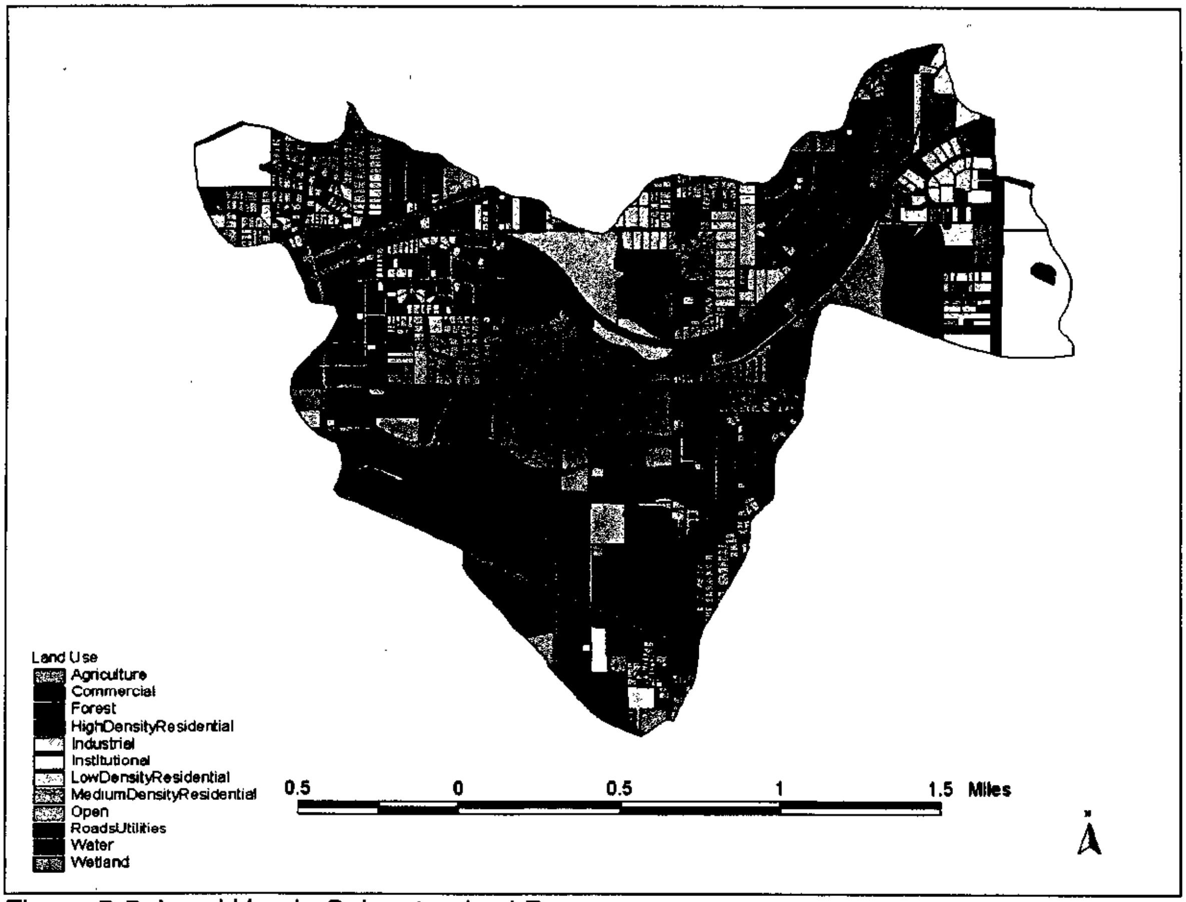

Figure 5-5. Land Use in Subwatershed B

Table 5-4. Land Use Categories in Subwatershed B

Land use	Acreage	Percentage of Watershed
Agriculture	52	2.9
Urban Open	133	7.5
Low density residential	55	3.1
Medium density residential	163	9.2
High density residential	375	21.2
Institutional	95	5.4
Industrial	56	3.2
Commercial	370	21.0
Roads/Utilities	248	14.1
Forest/rural open	92	5.2
Water/Wetland	126	7.1
Total	1765	100.0

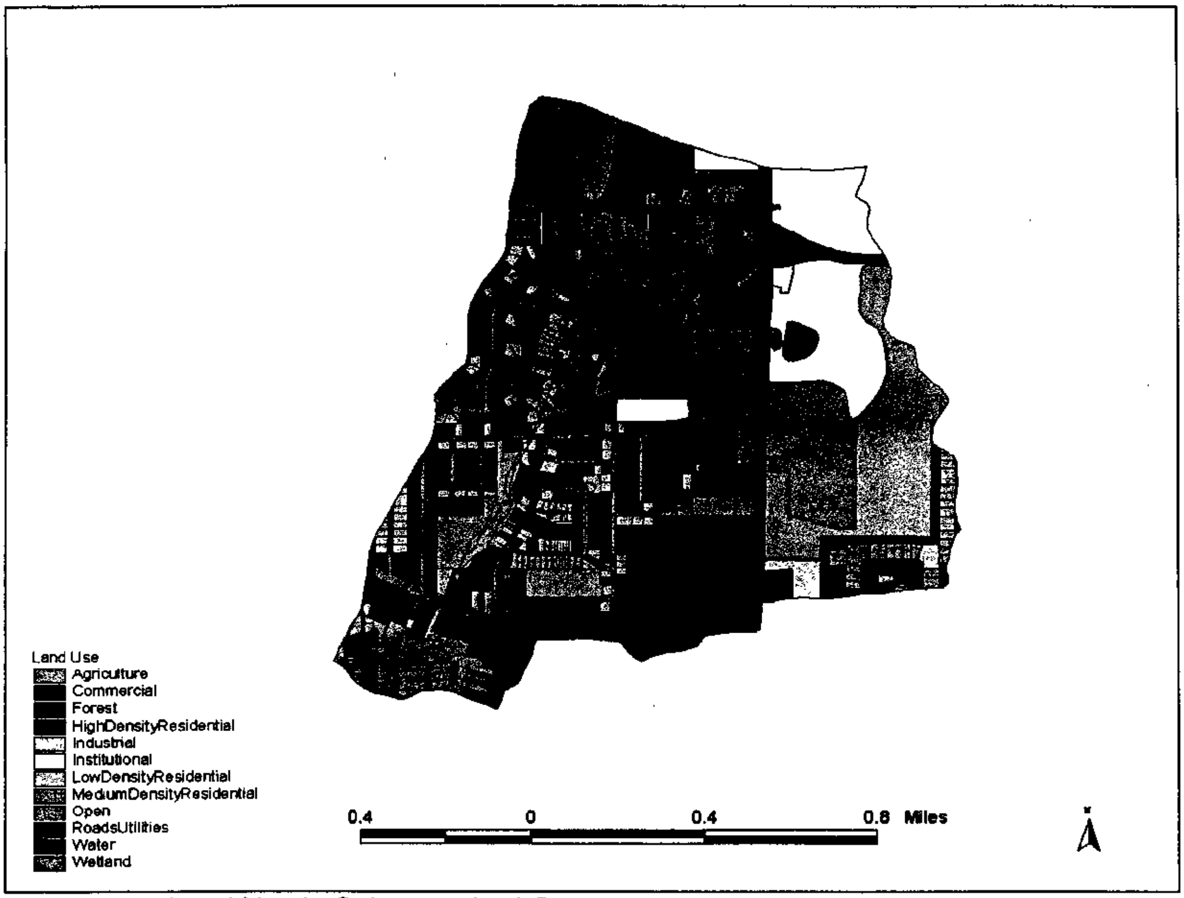

Figure 5-6. Land Use in Subwatershed C

Table 5-5. Land Use Categories in Subwatershed C

Land use	Acreage	Percentage of Watershed
Agriculture	79	9.3
Urban Open	107	12.5
Low density residential	2	0.2
Medium density residential	56	6.6
High density residential	209	24.5
Institutional	76	8.9
Industrial	5	0.6
Commercial	124	14.5
Roads/Utilities	118	13.8
Forest/rural open	13	1.5
Water/Wetland	64	7.5
Total	853	100.0

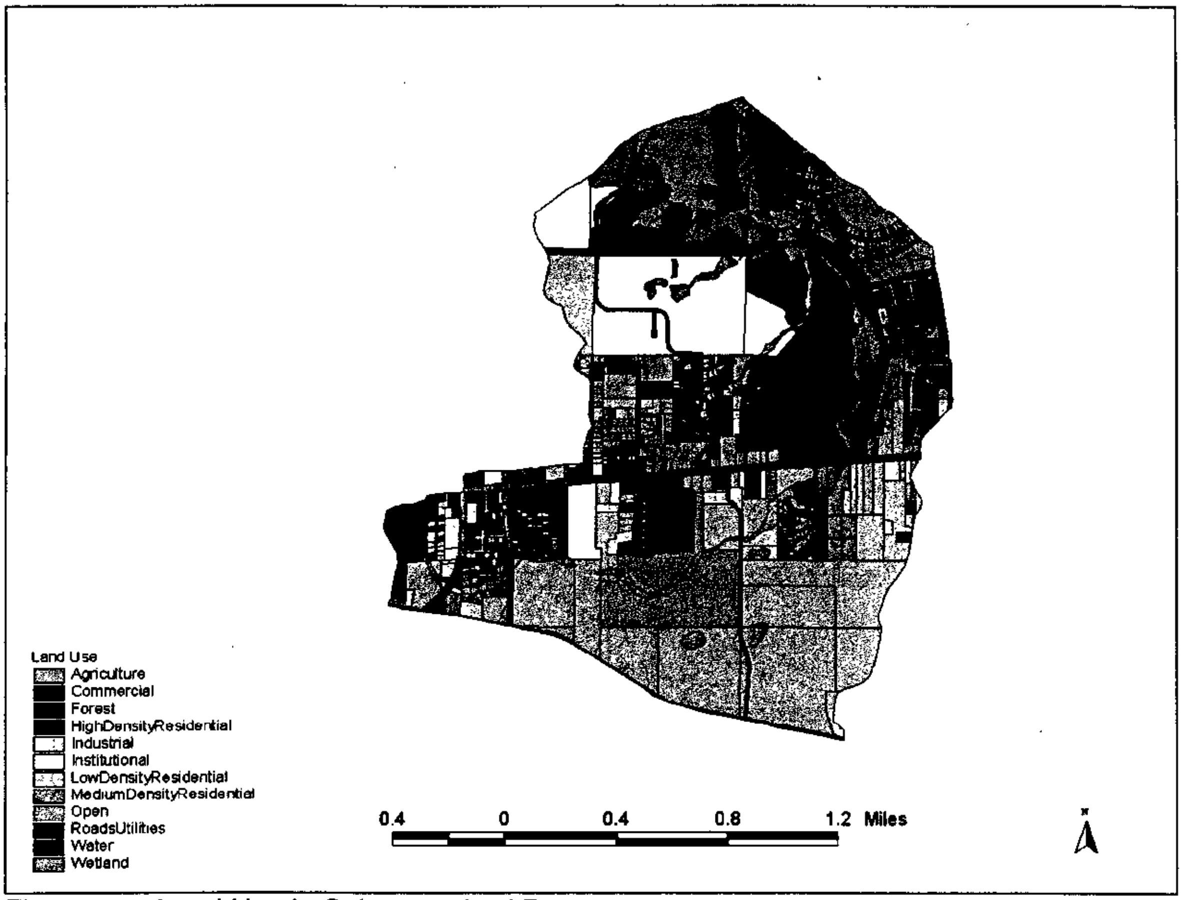

Figure 5-7. Land Use in Subwatershed D

Table 5-6. Land Use Categories in Subwatershed D

Land use	Acreage	Percentage of Watershed
Agriculture	510	27.4
Urban Open	279	15.0
Low density residential	36	1.9
Medium density residential	51	2.7
High density residential	325	17.4
Institutional	183	9.8
Industrial	11	0.6
Commercial	86	4.6
Roads/Utilities	174	9.3
Forest/rural open	94	5.0
Water/Wetland	115	6.2
Total	1864	100.0

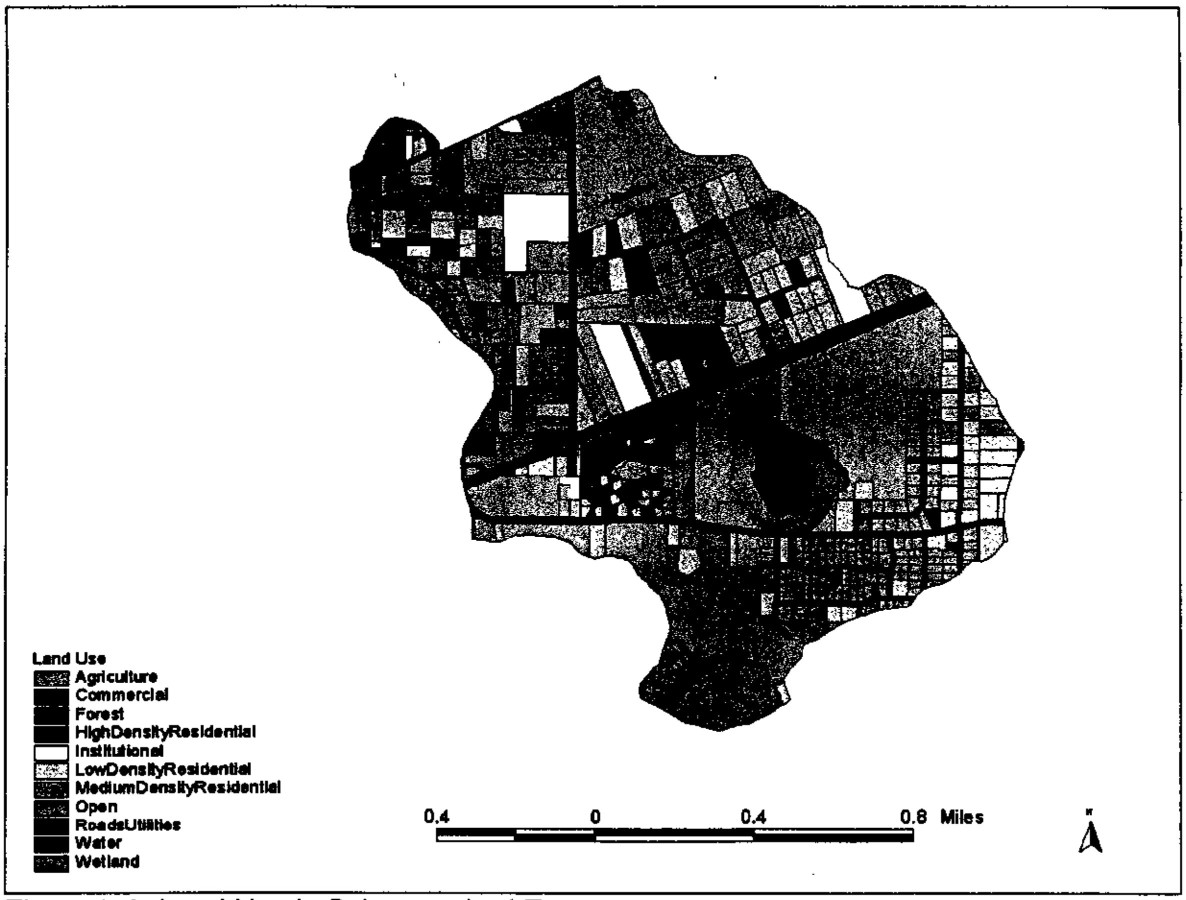

Figure 5-8. Land Use in Subwatershed E

Table 5-7. Land Use Categories in Subwatershed E

Land use	Acreage	Percentage of Watershed
Agriculture	293	28.7
Urban Open	225	22.0
Low density residential	125	12.2
Medium density residential	104	10.2
High density residential	82	8.0
Institutional	38	3.7
Industrial	0	0.0
Commercial	4	0.4
Roads/Utilities	95	9.3
Forest/rural open	2	0.2
Water/Wetland	53	5.2
Total	1021	100.0

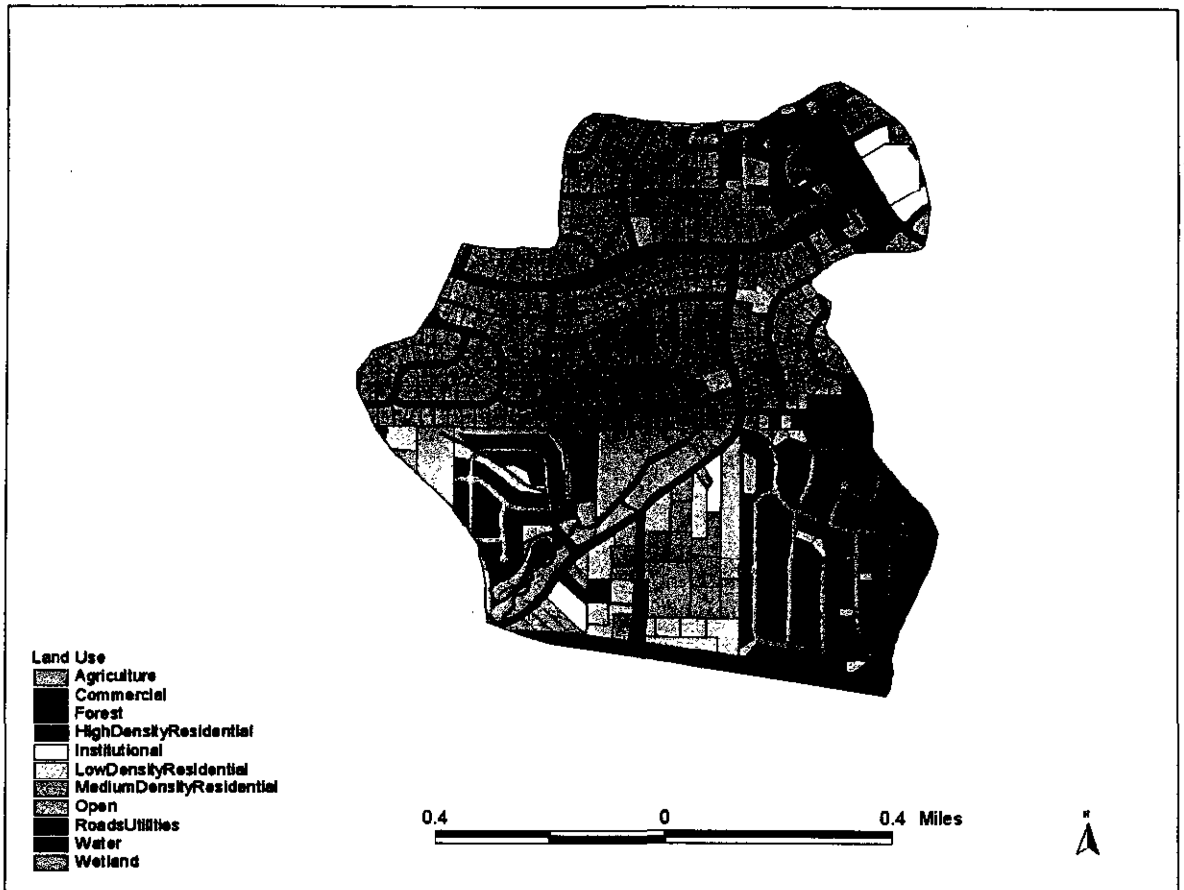

Figure 5-9. Land Use in Subwatershed F

Table 5-8. Land Use Categories in Subwatershed F

Land use	Acreage	Percentage of Watershed
Agriculture	23	4.8
Urban Open	45	9.5
Low density residential	20	4.2
Medium density residential	166	34.9
High density residential	99	20.8
Institutional	11	2.3
Industrial	0	0.0
Commercial	6	1.3
Roads/Utilities	94	19.7
Forest/rural open	2	0.4
Water/Wetland	10	2.1
Total	476	100.0

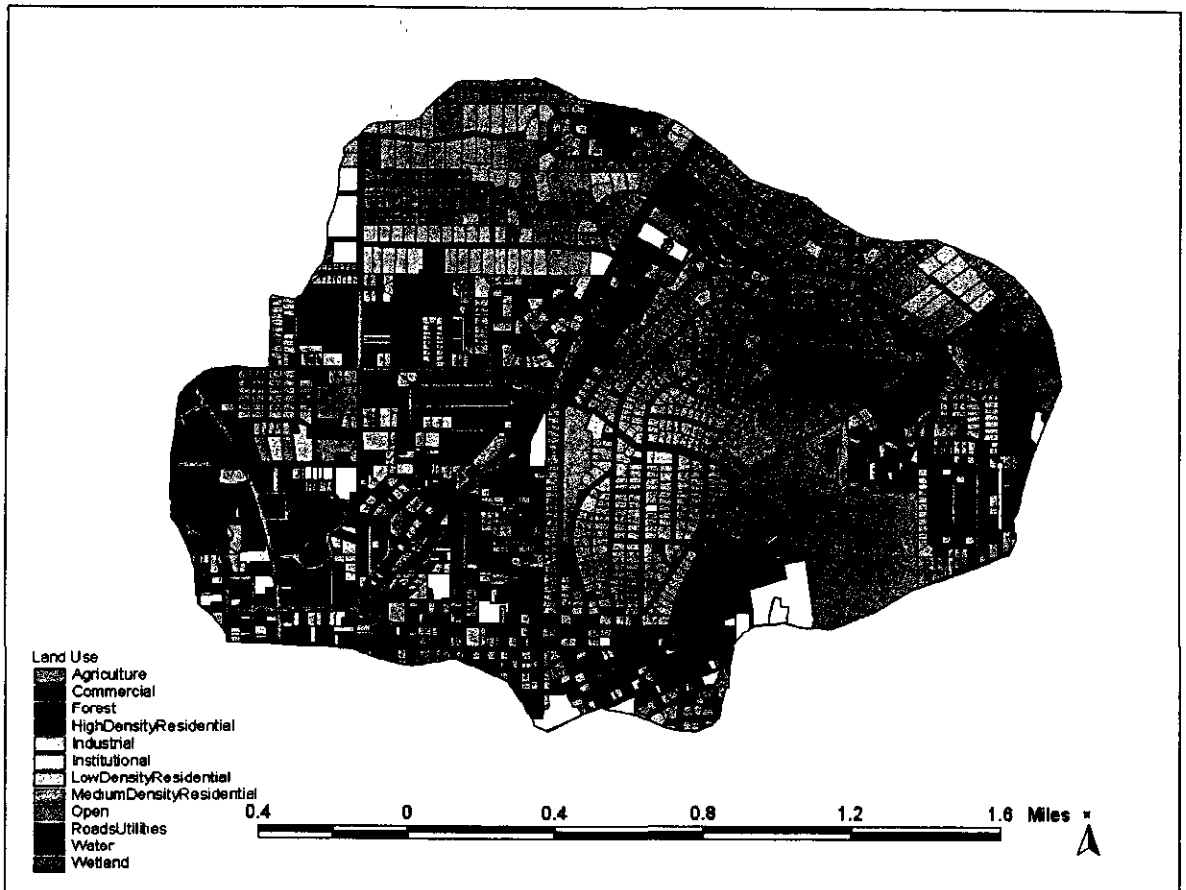

Figure 5-10. Land Use in Subwatershed G

Table 5-9. Land Use Categories in Subwatershed G

Land use	Acreage	Percentage of Watershed
Agriculture	37	1.9
Urban Open	246	12.5
Low density residential	144	7.3
Medium density residential	513	26.1
High density residential	324	16.5
Institutional	72	3.7
Industrial	2	0.1
Commercial	252	12.8
Roads/Utilities	317	16.1
Forest/rural open	2	0.1
Water/Wetland	58	2.9
Total	1967	100.0

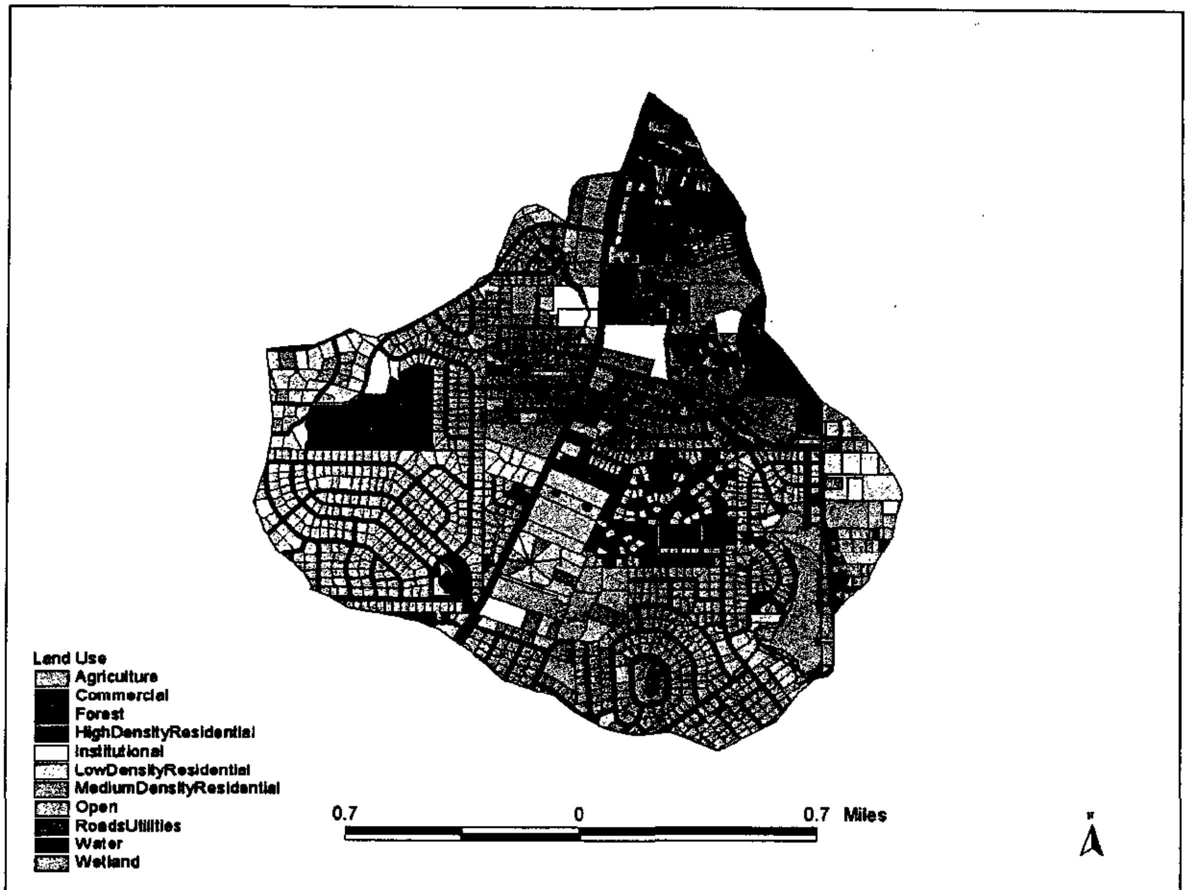

Figure 5-11. Land Use in Subwatershed H

Table 5-10. Land Use Categories in Subwatershed H.

Land use	Acreage	Percentage of Watershed
Agriculture	107	7.5
Urban Open	156	10.9
Low density residential	122	8.6
Medium density residential	497	34.9
High density residential	141	9.9
Institutional	38	2.7
Industrial	0	0.0
Commercial	80	5.6
Roads/Utilities	201	14.1
Forest/rural open	6	0.4
Water/Wetland	77	5.4
Total	1425	100.0

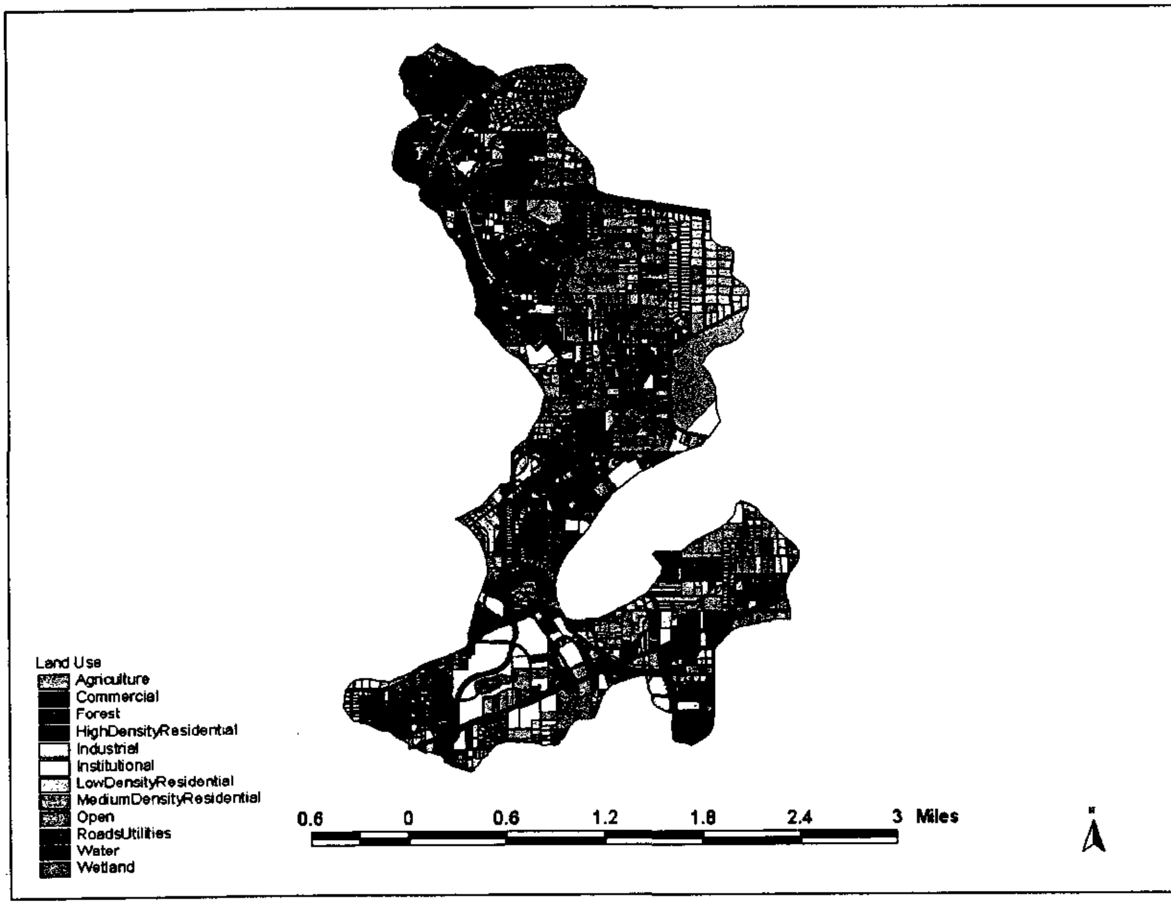

Figure 5-12. Land Use in Subwatershed M

Table 5-11. Land Use Categories in Subwatershed M

Land use	Acreage	Percentage of Watershed
Agriculture	331	9.0
Urban Open	586	16.0
Low density residential	254	6.9
Medium density residential	301	8.2
High density residential	444	12.1
Institutional	263	7.2
Industrial	67	1.8
Commercial	570	15.5
Roads/Utilities	584	15.9
Forest/rural open	39	1.1
Water/Wetland	227	6.2
Total	3666	100.0

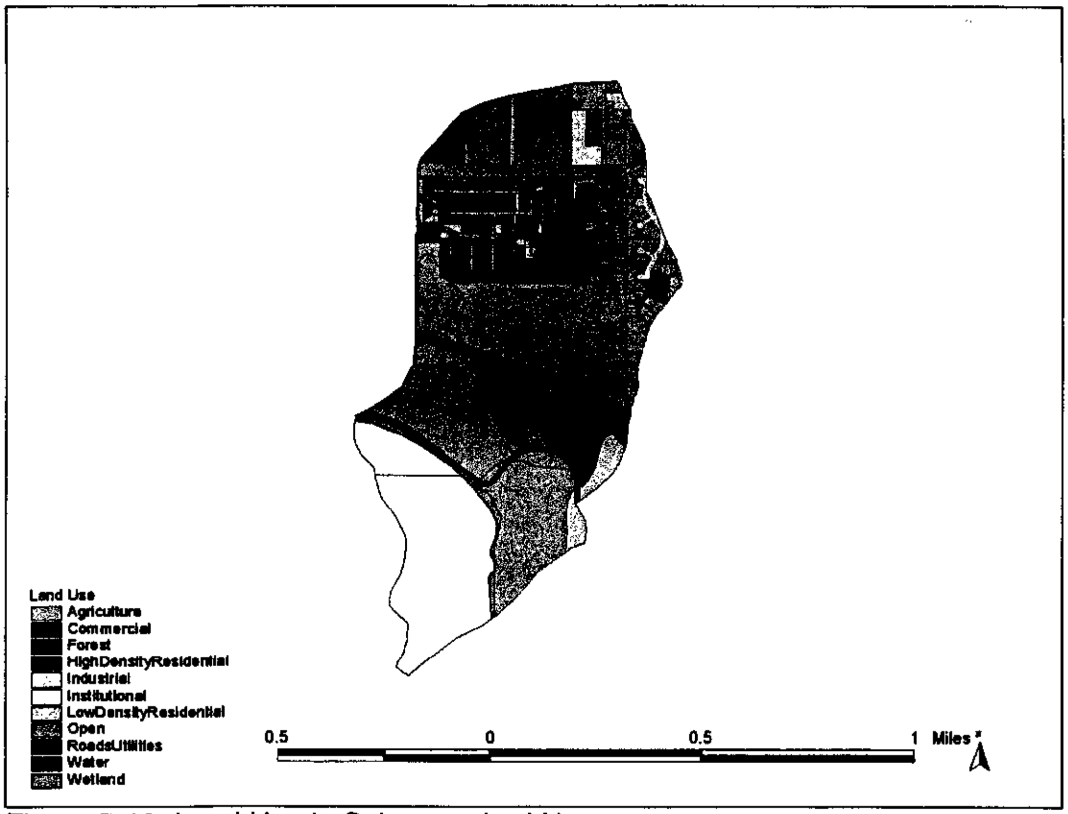

Figure 5-13. Land Use in Subwatershed N

Table 5-12. Land Use Categories in Subwatershed N.

Land use	Acreage	Percentage of Watershed
Agriculture	17	4.0
Urban Open	172	40.2
Low density residential	7	1.6
Medium density residential	0	0.0
High density residential	48	11.2
Institutional	70	16.4
Industrial	4	0.9
Commercial	5	1.2
Roads/Utilities	29	6.8
Forest/rural open	27	6.3
Water/Wetland	49	11.4
Total	428	100.0

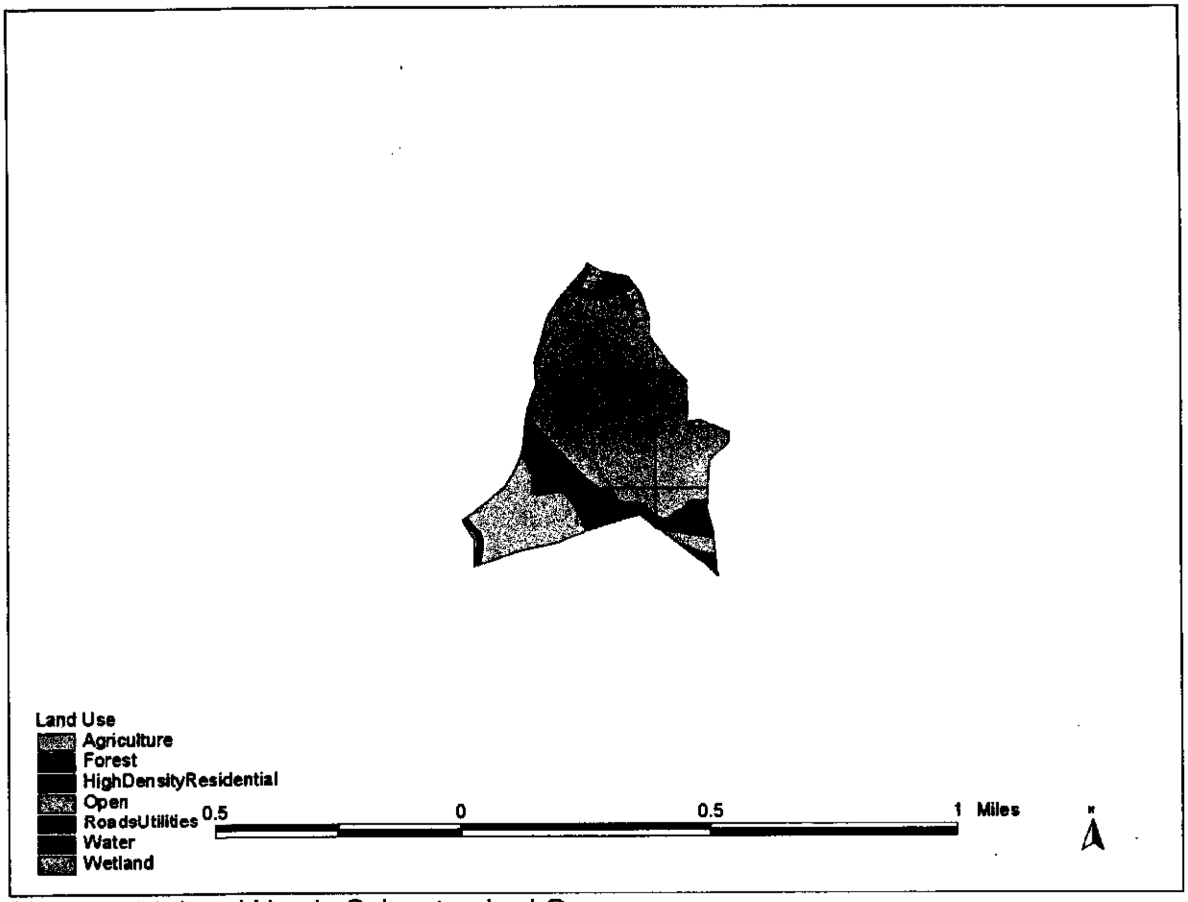

Figure 5-14. Land Use in Subwatershed O

Table 5-13. Land Use Categories in Subwatershed O

Land use	Acreage	Percentage of Watershed
Agriculture	17	14.5
Urban Open	19	16.2
Low density residential	0	0.0
Medium density residential	0	0.0
High density residential	1	0.9
Institutional	0	0.0
Industrial	0	0.0
Commercial	0	0.0
Roads/Utilities	9	7.7
Forest/rural open	9	7.7
Water/Wetland	62	53.0
Total	117	100.0

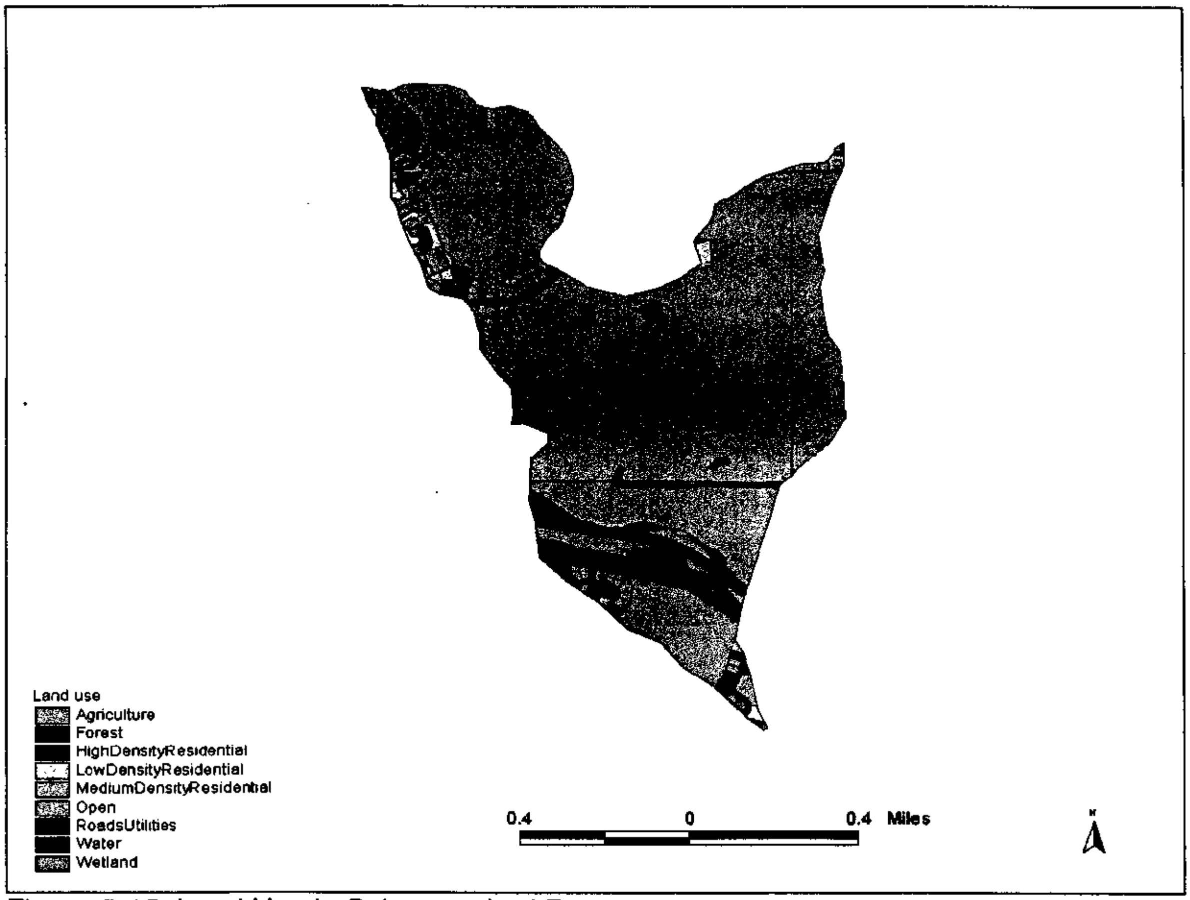

Figure 5-15. Land Use in Subwatershed P

Table 5-14. Land Use Categories in Subwatershed P

Land use	Acreage	Percentage of Watershed
Agriculture	4	0.8
Urban Open	255	48.9
Low density residential	5	1.0
Medium density residential	4	0.8
High density residential	6	1.1
Institutional	0	0.0
Industrial	0	0.0
Commercial	0	0.0
Roads/Utilities	16	3.1
Forest/rural open	19	3.6
Water/Wetland	213	40.8
Total	522	100.0

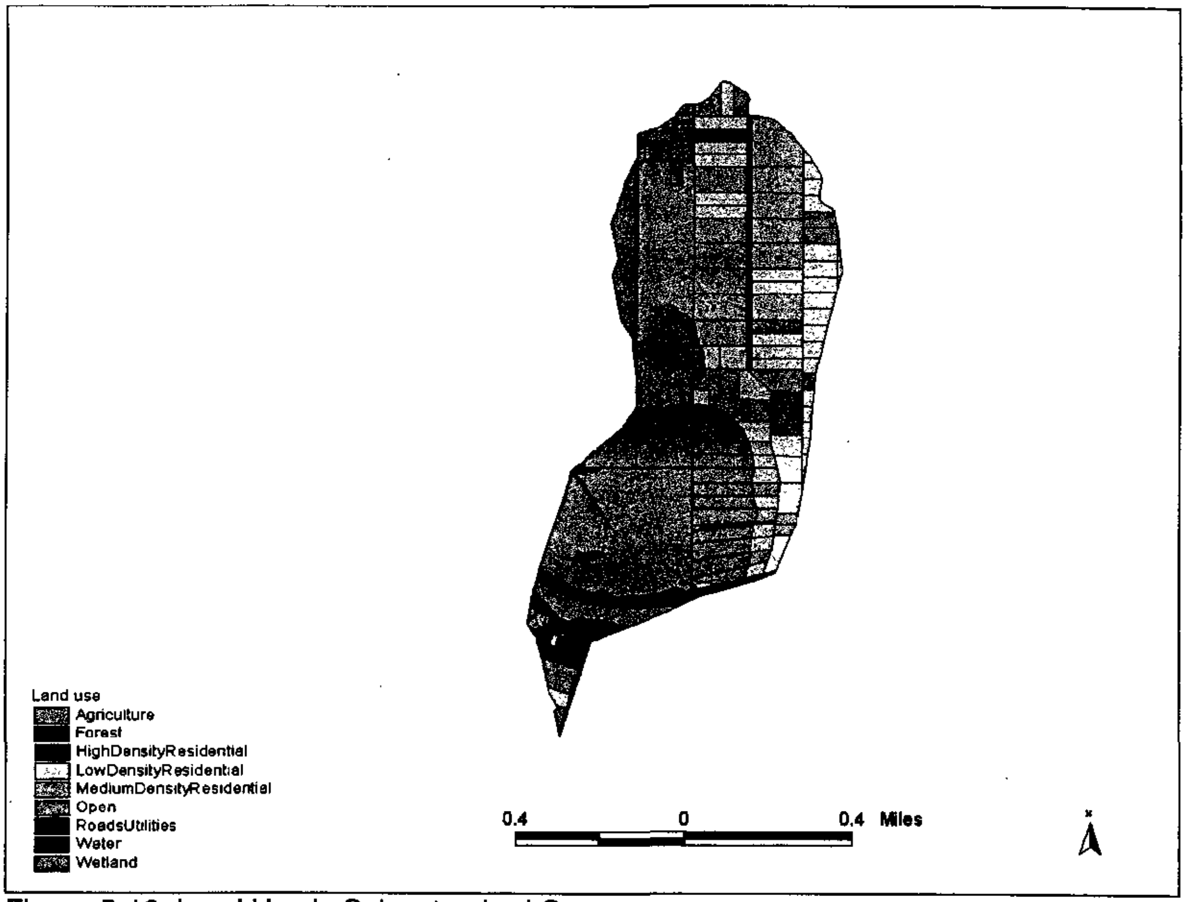

Figure 5-16. Land Use in Subwatershed Q

Table 5-15. Land Use Categories in Subwatershed Q

Land use	Acreage	Percentage of Watershed
Agriculture	124	30.5
Urban Open	41	10.1
Low density residential	66	16.3
Medium density residential	8	2.0
High density residential	6	1.5
Institutional	0	0.0
Industrial	0	0.0
Commercial	0	0.0
Roads/Utilities	16	3.9
Forest/rural open	3	0.7
Water/Wetland	142	35.0
Total	406	100.0

5.2.3 PERCENT IMPERVIOUS AREA

Percent impervious area of each land use category is a very important parameter in estimating surface runoff using WMM. Non-point pollution monitoring studies throughout the U.S. over the past 15 years have shown that annual "per acre" discharges of urban stormwater pollution are positively related to the amount of imperviousness in the land use (WMM User's Manual 1998). Ideally, impervious area is considered as the area that does not retain water and therefore, 100% of the precipitation falling on the impervious area should become surface runoff. In practice, the runoff coefficient for impervious area typically ranges between 0.95 and 1.0. Impervious runoff coefficients lower than this range were observed in the literature, but usually this number should not be lower than 0.8. For pervious area, the typical range for the runoff coefficient is between 0.05 and 0.30. (WMM User's Manual: 1998). In this study, 0.85 was used as the runoff coefficient for impervious area and 0.05 was used as the runoff coefficient for pervious area.

It should be noted that the impervious area percentages do not necessarily represent directly connected impervious area (DCIA). Using a single-family residence as an example, rain falls on rooftops, sidewalks, and driveways. The sum of these areas may represent 30% of the total lot. However, much of the rain that falls on the roof drains to the grass and infiltrates to the ground or runs off the property and thus does not run directly to the street. For WMM modeling purpose, whenever the area of the watershed that contributes to the surface runoff was considered, DCIA was used in place of impervious area. Local values for percent imperviousness were available in the Leon County EPA NPDES MS4 Permit Application. DCIAs are typically 50% of the percent imperviousness for a given land use category, so the DCIA used here represents half of the percent imperviousness.

Table 5-16. Percent Direct Connected Impervious Area for Different Land Use Categories

Land use Categories	DCIA (%)
Forest/Rural Open	0.50
Urban Open	0.50
Agriculture	1.00
Low Density Residential	6.50
Medium Density Residential	12.50
High Density Residential	25.00
Highways	18.10
Water	30.00
Wetlands	30.00
Commercial	18.10
Industrial	18.10
Institutional	18.10

5.2.4 EMC DATA

Local event mean concentrations (EMCs) of TN and TP for different land use categories were available locally from Leon County EPA NPDES MS4 Permit Application and from the City of Tallahassee (Appendix C). WMM requires EMCs for TKN and nitrate/nitrite.

Table 5-17. Local Event Mean Concentrations [EMCs (mg/L)] of TN and TP for Different Land Use Categories

Land use Categories	TP	TKN	NO23
Agriculture	0.34	1.76	0.56
Commercial	0.15	1.24	1.05
Forest	0.05	0.95	0.3
High Density Residential	0.24	0.94	0.53
Roads/Utilities*	0.22	0.94	0.53
Industrial	0.15	1.24	1.05
Low Density Residential	0.44	1.34	0.63
Medium Density Residential	0.45	1.77	0.27
Urban Open	0.05	0.95	0.3
Water	0.17	0.6	0.19
Wetland	0.17	0.6	0.19
Institutional	0.15	1.24	1.05

Source: Leon County NPDES Phase I Permit Application

* Literature value (Baird, et. al, 1996)

EMCs of TN and TP for most land use categories were cited from available local information from Leon County. The land use categories with available EMCs were not directly defined in the Leon County permit application, so some extrapolations were made between the land use categories defined in the permit application and those used in this study. EMCs for Agriculture, Institutional, Wetland, Commercial, Low Density Residential, Medium Density Residential, and high Density Residential were directly available in the permit application, but EMCs for Forest, Industrial, Water, and Roads/Utilities were not, so for these categories, EMCs from similar land use types available in the application were used. However, this source did not contain EMCs for the Roads/Highways category, so an EMC value obtained from literature (Baird, et. al, 1996) was used.

5.2.5 PERCENT NITROGEN AND PHOSPHORUS IN DISSOLVED FORM

Not all the TN and TP are transported by the stormwater in the dissolved form. The percentage of the total EMC represented by TN and TP attached to suspended particles is allowed to be defined in WMM. Percent suspended TN and TP values were reported by Lasi (1999) for Orange Lake watershed in Alachua County and, in absence of site specific information, were used in this study (Table 5-18).

Table 5-18. Percent TP and TN in Suspended Form for Different Land Use Categories

Land use Categories	TP	TN
Agriculture	38%	20%
Commercial	57%	44%
Forest	28%	6%
High Density Residential	57%	44%
Roads/Utilities	57%	44%
Industrial	57%	44%
Low Density Residential	57%	44%
Medium Density Residential	57%	44%
Urban Open	57%	44%
Water	48%	77%
Wetland	48%	77%
Institutional	57%	44%

5.2.6 SEDIMENT DELIVERY RATIO

The sediment delivery ratio determines how much TN and TP attaching to suspended particles will eventually be delivered to the destination waterbody to account for the settling out of suspended pollutants in a stream channel. In this study, the range of sediment delivery ratio was estimated using the correlation between delivery ratio and watershed area developed by Roehl (1962). Because of the difference in total area of the watershed and relative distance of each subwatershed to Upper Lake Lafayette, each of the subbasins was assigned different sediment delivery ratios, which are listed in Table 5-19.

Table 5-19. Sediment Delivery Ratios for Upper Lake Lafayette Subwatersheds

Subwatershed	Sediment Delivery Ratio
A	0.260
B	0.291
C	0.243
D	0.223
E	0.239
F	0.258
G	0.221
H	0.229
M	0.183
N	0.262
O	0.302
P	0.256
Q	0.263

5.2.7 SEPTIC TANK FAILURE LOADING RATE

To estimate the TN and TP loadings from leakage of septic tanks, WMM incorporates the concept of "septic tank failure loading rate" which defines the percent increase of TN and TP loadings associated with an annual percentage of failing septic systems in low density residential areas. The annual failure rate is based on a percentage of septic systems that fail per year of operation. For annual average conditions, the WMM Users Manual states that it is conservative to assume that septic tank system failures go unnoticed or untreated for five years prior to repair or replacement. (WMM User Manual, 1998) Septic tank repair frequency for this area is unknown, but annual septic tank repair rates in the U.S. range from 1-3 percent. For this watershed, a 2% annual repair frequency was assumed. The septic tank failure loading rate for the Upper Lake Lafayette watershed was calculated by multiplying repairing frequency (2%) by 5 years, resulting in a 10% loading rate.

Pollutant loading rates reported in the WMM Users Manual assume 50 gallons per capita per day usage. These rates were developed from a review of septic tank leachate monitoring studies. The range of loading rates for TP is from 1.0 mg/L to 4.0 mg/L and 7.5 mg/L to 30.0 mg/L for TN. The lower end of each range was adopted for purposes of this study, at 1.0 mg/L for TP and 7.5 mg/L for TN.

The septic tank failure loading rate, the pollutant loading rate, and any analysis of potential septic impact was included only for land use categories Low Density Residential and Medium Density Residential. Based upon this methodology, failing septic systems in the watershed would contribute less than 5 percent of total nonpoint loadings.

5.2.8 SUBWATERSHED LOADING

To estimate the TN and TP loading from each of the subwatersheds, loading from each subwatershed was treated as an incoming load to the downstream subwatersheds. For example, in order to calibrate WMM to water quality data at Weems Road, loading from subwatershed C was treated as a source to subwatershed B, which was then treated as a source to subwatershed M (see Figure 4-1 for locations of subwatersheds). Subwatersheds A, F, G, and H were also included as sources to subwatershed M.

<u>WMM calibration for surface runoff and TN and TP loading from subwatersheds</u>

By using the measured data and model parameters discussed above, WMM was calibrated to estimate the surface runoff and total TN and TP loading to the measured data at the Weems Road monitoring station and DEP Flow Gage 690 for the critical 1998 year. The measured results for each parameter for the 1996-2000 time period were calculated using flow-weighted concentrations and are listed in Table 5-20. Weems Because the monitoring station is at the outflow of Weems Pond, there is no consideration of nutrient uptake from Weems Pond. This is a conservative assumption, especially during low flow conditions.

Because the nutrient concentration in Upper Lake Lafayette is a function of flow, the inflow concentrations (loading concentrations from WMM) are flow-weighted. These are used as input to BATHTUB

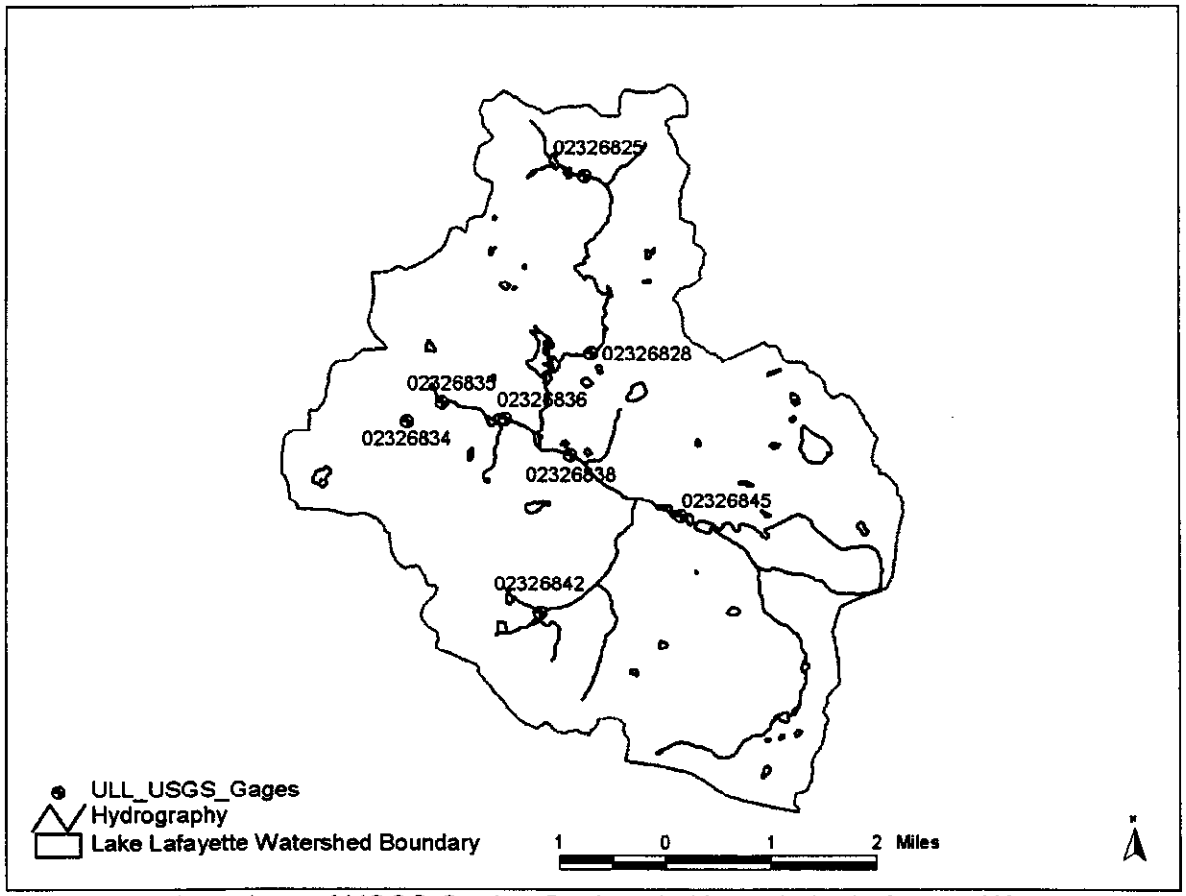

Figure 5-17. Locations of USGS Gaging Stations in Upper Lake Lafayette Watershed.

Table 5-20. Measured Flow at DEP Flow Gage 690 and Annual Average TN and TP Concentrations at Weems Road

Year	Mean Daily Flow (cfs)	TP (mg/l)	TN (mg/l)
1996	7.8	0.245	0.480
1997	20.75	0.298	0.413
1998	12.47	0.254	0.567
1999	5.27	0.089	0.550
2000	9.38	0.448	0.432

WMM Flow Calibration

Flow calibration was conducted using the data from 1998 for the FDEP Flow Gage 690. Although a number of USGS gages are located within the Upper Lake Lafayette watershed, none of these have a continuous flow record for the period of study. FDEP Flow Gage 690 also does not have a continuous flow record for the entire verified period, so flows at this gage, located on the Northeast Drainage Ditch upstream of Weems Pond, are estimated based on the sum of the flow at two gages from adjacent drainage areas. NWFWMD Gage S72 is collocated with FDEP Flow Gage 685 and NWFWMD Gage 100 is collocated with FDEP Flow Gage 740. Figure 5-18 contains the locations of these gages.

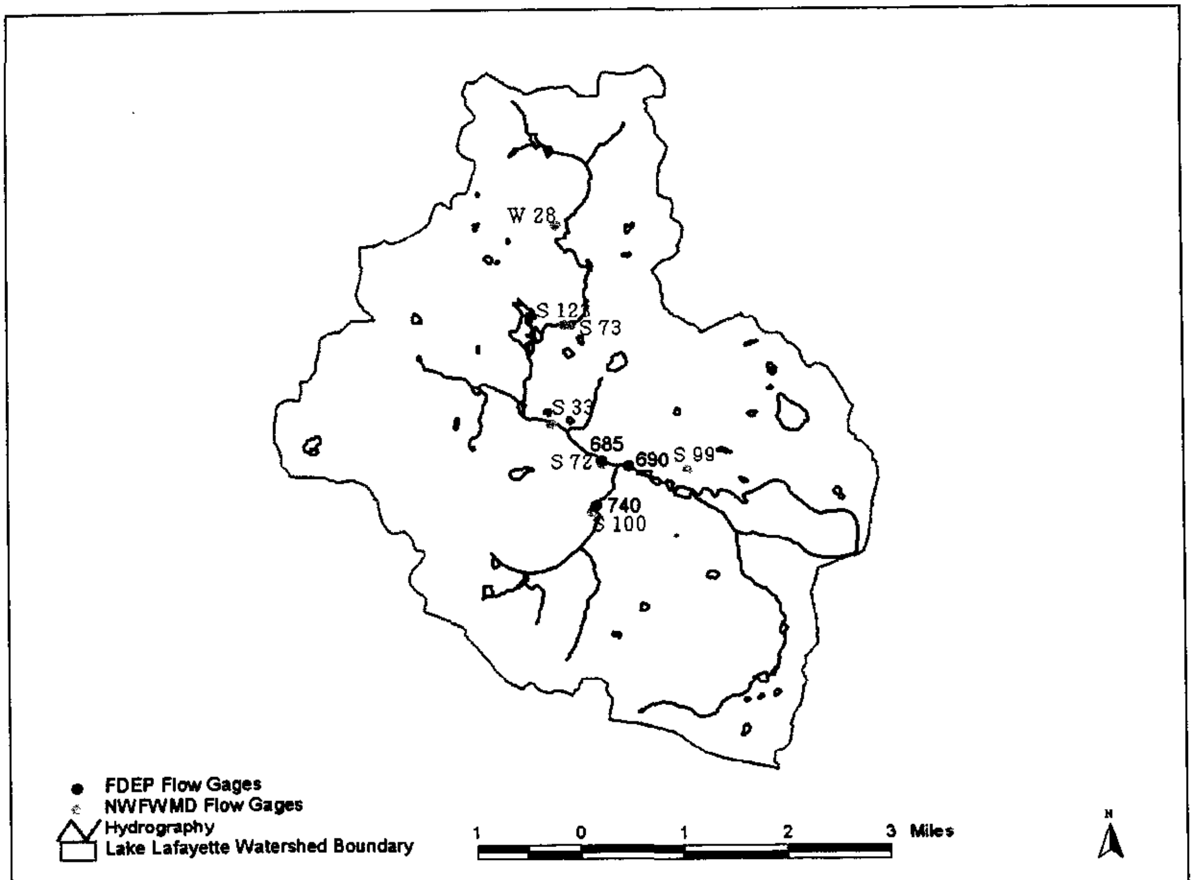

Figure 5-18. Locations of NWFWMD Gaging Stations and FDEP Flow Gages in Upper Lake Lafayette Watershed.

Flow calibration was primarily conducted by adjusting the runoff coefficients for pervious and impervious land use area to fit the model predictions to the actual measurements. Table 5-21 shows the measured flow at Station 690 and the predicted flow with a percent error. The flow to Station 690 was predicted by considering surface runoff from contributing watersheds A, B, C, F, G, H, and M.

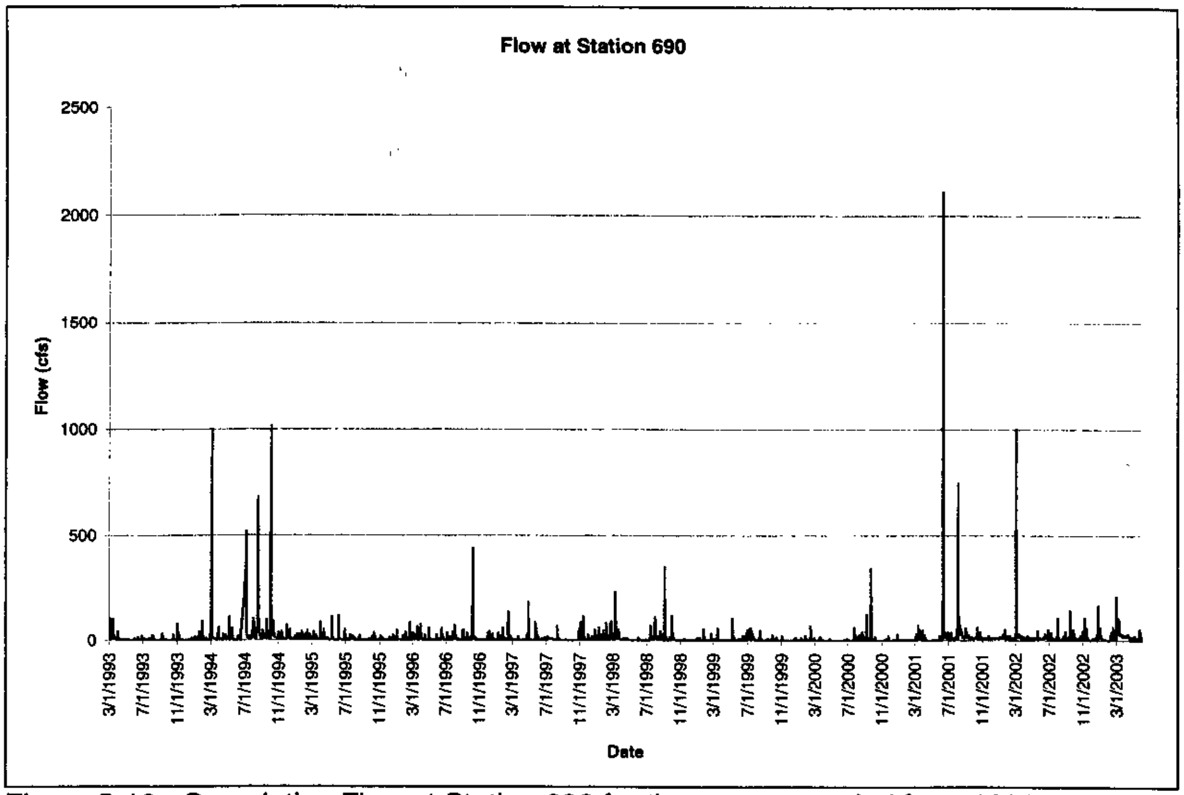

Figure 5-19. Cumulative Flow at Station 690 for the ten year period from 1993-2003. The flow at 690 was obtained by combining flow at contributing gages.

Table 5-21. Results of WMM Water Quantity (Flow) Calibration Estimated Annual Flow into Upper Lake Lafayette and Surface Runoff from Contributing Subwatersheds (A, B, C, F, G, H, and M) (acre-foot/year)

Year	Measured Annual Flow	Predicted Annual Flow	Pervious Runoff Coefficient	Impervious Runoff Coefficient	Percent Error
1998	9028	8823	0.05	0.85	2%

WMM Water Quality Calibration and Simulation of Watershed Loadings

WMM water quality calibration for the subwatersheds contributing to the Weems Road monitoring station (A, B, C, F, G, H, and M). The calibrated model was then used to estimate the TN and TP loading from subwatersheds E, D, N, Q, O, and P. Monitoring data was available at the Weems Road monitoring station from 1996 through 2000. The 1998 data set was used for model calibration and flow-weighted concentrations were used to calculate annual loads. After the best fit between predicted loads and these measured loads was achieved for Subwatershed M (which included contributing subwatersheds A, B, C, F, G, and H), model estimates of TN and TP loadings for the other subwatersheds were also obtained.

The WMM user's manual recommends that WMM calibration on water quality be through adjusting the sediment delivery ratio while other model parameters remain constant. This approach was not used in this study because adjusting the sediment delivery ratio in this manner resulted in unreasonably high ratios. The delivery ratio was instead calculated using the delivery ratio to watershed area correlation discussed by Roehl (1962).

Once the sediment delivery ratios were defined, no further parameter adjustment was used for TP. TN loads were calibrated by adjusting the percentage of TN attached to suspended particles. The results from the water quality calibration to 1998 measured loads are shown in Table 5-22.

Table 5-22. Measured and Predicted TN and TP Loadings to Weems Road Station (kg/year)

Year	Measured Annual TN	Predicted Annual TN	Measured Annual TP	Predicted Annual TP	% Error TN	% Error TP
1998	3924	4909	2743	2604	22.00	-5.07

Table 5-23. Predicted TN and TP Loadings from Contributing Subwatersheds to Upper Lake Lafayette (Weems Rd. subwatershed is composed of subwatersheds draining to the Weems Rd. monitoring station - Subwatersheds A, B, C, F, G, H, M, and N) (kg/year)

Weems Rd.		Q		P		O		E		D	
TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP
4369	2566	109	86	109	86	29	24	303	181	670	332

As expected, the majority of the TN and TP loading to Upper Lake Lafayette is attributed to subwatershed M, which includes contributing subwatersheds and most of the land area of the watershed. Reducing loading from the Northeast Drainage Ditch (the tributary in subwatershed M) should be the main priority to target TP control.

Modeling the No-Load Condition

The non-anthropogenic background TN and TP loading (the loading without those generated from the existing level of human activities in the Upper Lake Lafayette watershed) was estimated using the following procedures:

1. All human land use categories (urban open, agricultural, low density residential, medium density residential, high density residential, roads/utilities, industrial, institutional, and commercial) in all subwatersheds were evaluated as forest/open. Septic system impacts were removed. Water and wetland land use categories remained unchanged.

2. TN and TP loadings were then estimated using the calibrated WMM and a mean average precipitation over the verified period of 54.18 inches/year.

3. Flow of the land use categories of forest/open, water, and wetland in contributing subbasins was then aggregated.

4. The resultant loads were compared to the 1998 TN and TP loads.

Table 5-24. Results of Modeling No-Load Condition

Precipitation	Predicted Annual Flow	Predicted Annual TN	Predicted Annual TP
54.18 in/yr	3526 ac-ft/yr	2241 kg/yr	280 kg/yr

The no-load condition is 93% lower than existing TP loads and 57% lower than existing TN loads.

5.3 ESTABLISHING THE RELATIONSHIP BETWEEN TN AND TP LOADING AND IN-LAKE TN, TP, AND CHL-A CONCENTRATIONS

The relationship between TN and TP loading and the resultant in-lake TN and TP concentrations were established by correlating BATHTUB model predictions with measured TN and TP concentrations at the Upper Lake Lafayette water quality monitoring station located in the sinkhole. The following data were required for model calibration:

1. Physical characteristics of Upper Lake Lafayette (surface area, mean depth, and mixed layer depth)
2. Meteorological data (precipitation and evaporation)
3. Measured water quality data (TN, TP, and Chl a concentrations)
4. Loading data (flow and TN and TP concentrations of flow from various sources)

Physical Characteristics of Upper Lake Lafayette

Runoff from the Upper Lake Lafayette watershed predominantly drains to Upper Lake Lafayette via the Northeast Drainage Ditch, Lafayette Creek, and, at high water level conditions, from Lake Piney Z. While the Buck Lake subwatershed also appears to be hydrologically connected to Upper Lake Lafayette, anecdotal evidence suggests that flows from that subwatershed rarely make it to the lake, and possibly drain to a separate sinkhole within Buck Lake. The Upper Lake Lafayette elevation is known to vary significantly, from elevations as high as 40-45 feet (i.e. immediately after large rainfall events) down to approximately 25 feet (after extended dry periods), when only the sinkhole is wet. Since the BATHTUB model is run at steady state conditions

The Upper Lake Lafayette volumetric storage is known to vary dynamically depending on storm event inflow and subsequent sinkhole drainage. For purposes of this study, a volume representing the critical condition of the lake area including the lake bed around Lafayette Sink, which is at the 34 foot elevation. , a single lake elevation of 34 feet was identified to characterize typical, or average, conditions.

Figure 5-20 presents an aerial photograph of Upper Lake Lafayette taken during January 2001, when the lake area extends only minimally beyond Lafayette Sink. Compare this photograph to Figure 5-21, taken in August 2001, following several rain events and increased flow to the lake, when the area of the lake extended to the treeline and encompassed the entirety of the lake bed surrounding Lafayette Sink. Also note the August 2001 algae bloom, when the emerald green color of Lake Lafayette was apparent by air (McGlynn, personal comm., 2004).

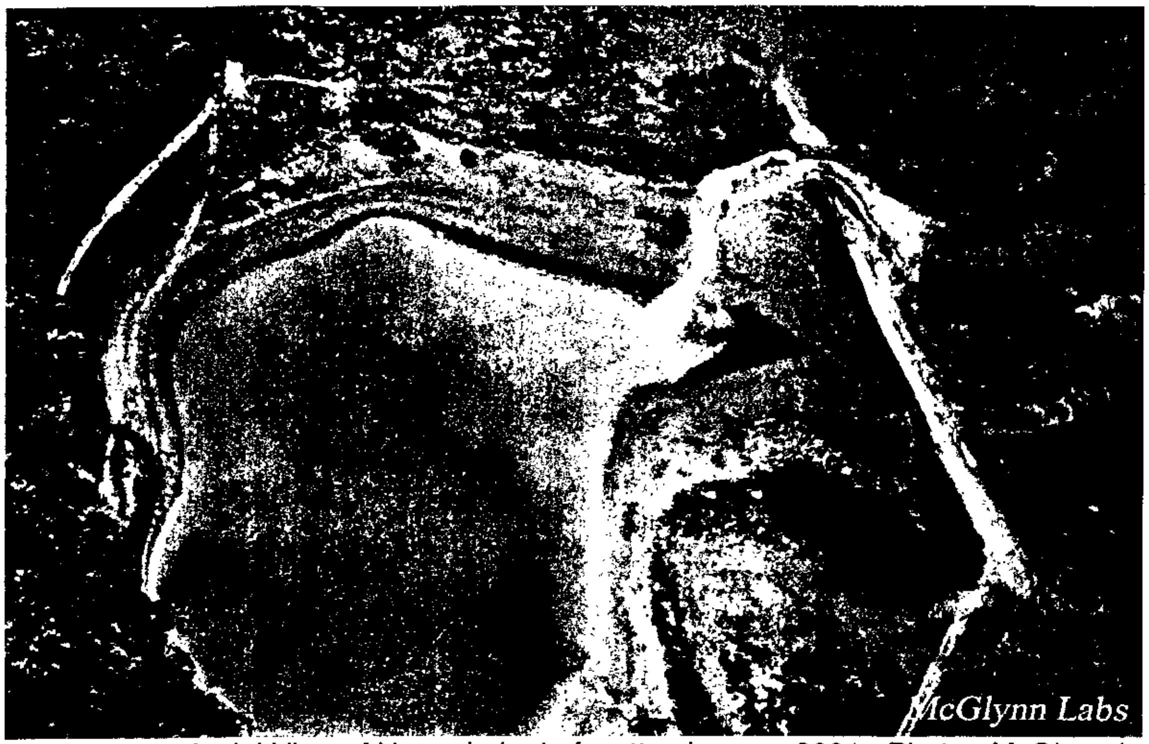

Figure 5-20. Aerial View of Upper Lake Lafayette, January 2001. Photo: McGlynn Labs

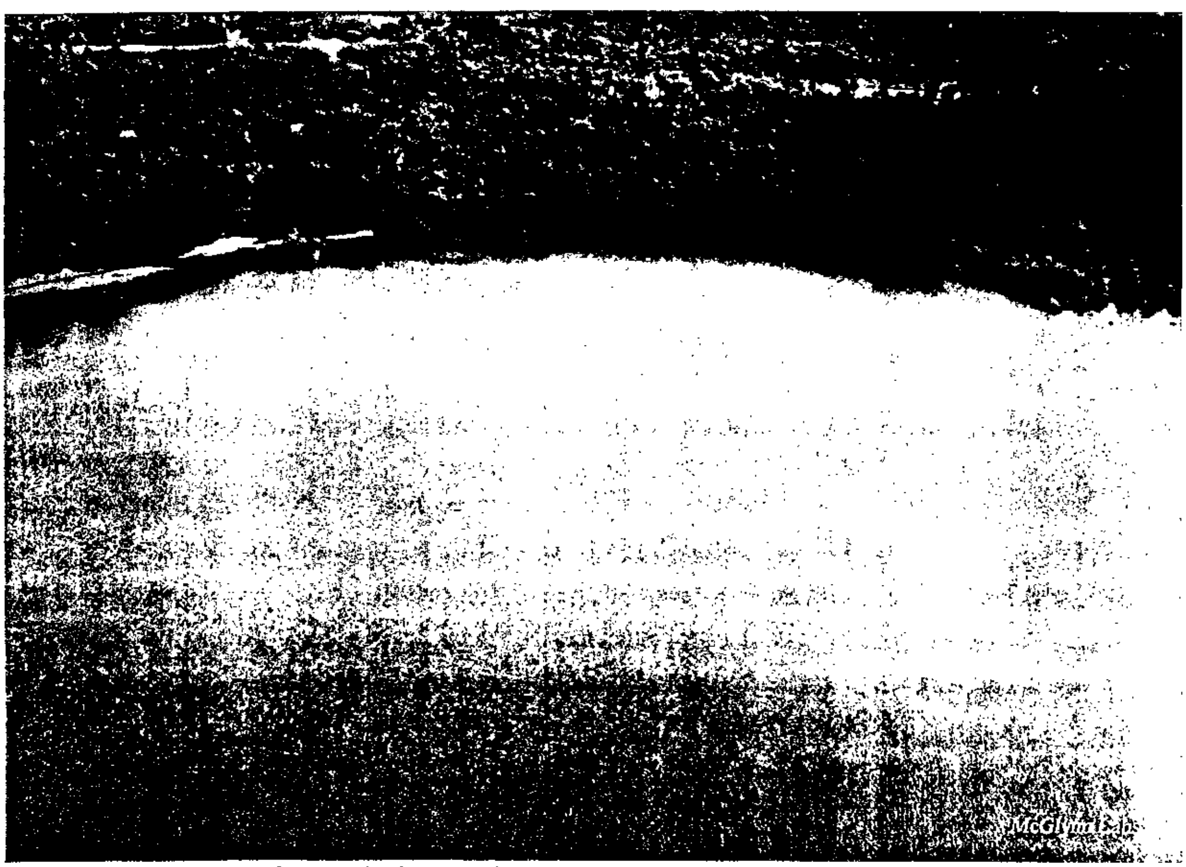

Figure 5-21. View of Lake Lafayette bank in August 2001 following several rain events.

The boundary of the lake at 34 feet, as shown in Figure 5-22, was established from a GIS layer of 2-foot contours obtained from the Tallahassee/Leon County Interlocal GIS department. This contour was then split up into 4 "segments" for the BATHTUB model, isolating (a) the Northeast Drainage Ditch tributary arm to the west, (b) the eastern portion of the lake closest to Lake Piney Z, (c) the main body of the lake, and (d) the sinkhole. These segments are also identified in Figure 4-1. The surface areas and volumes of each segment were determined within ArcView, using the segment boundaries, the contour layer, and anecdotal information about the sinkhole's depth (45-50 feet). Table 5-25 shows these calculated areas and volumes and also includes an equivalent mean depth for each segment, calculated as the quotient of the segment volume and surface area. While some stratification is suspected within the sinkhole segment, mixed layer depths for all segments were set equal to the mean depth.

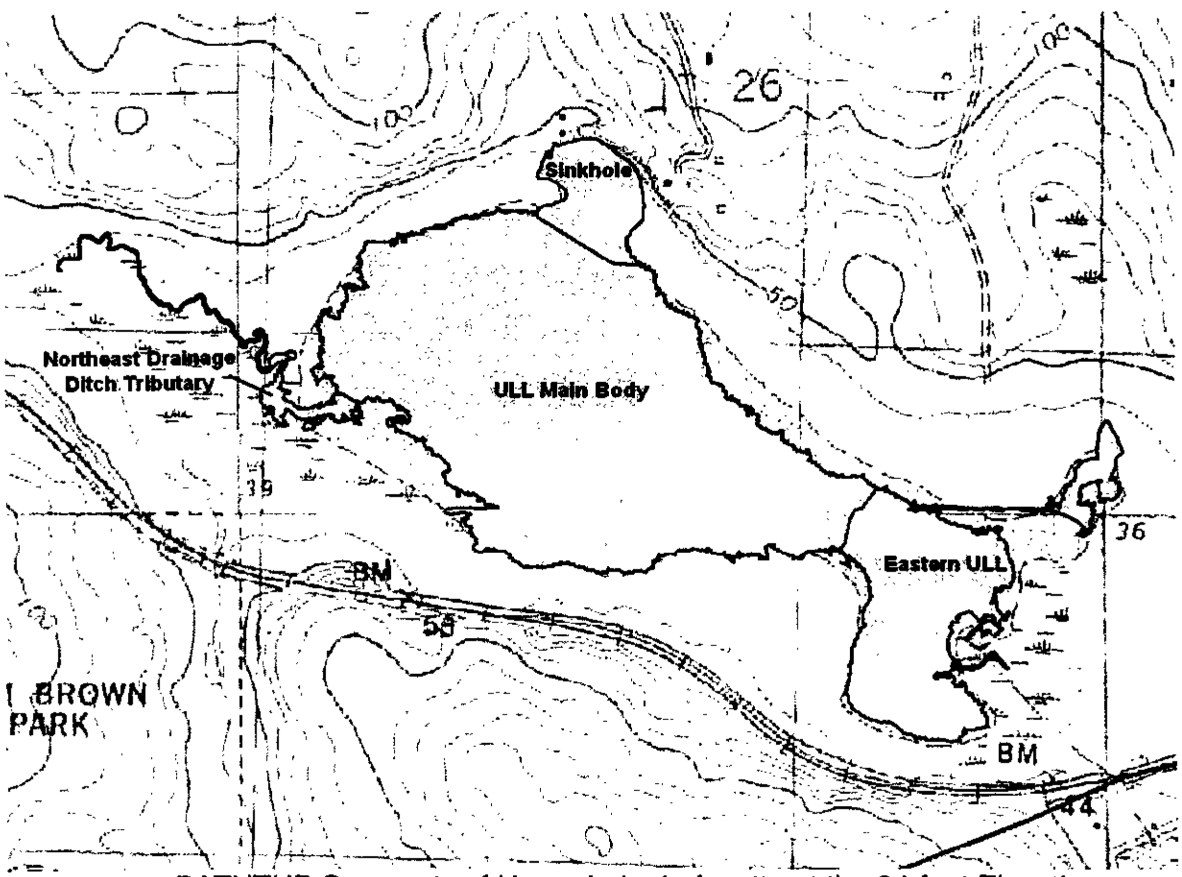

Figure 5-22. BATHTUB Segments of Upper Lake Lafayette at the 34-foot Elevation

Table 5-25. Physical Characteristics of Upper Lake Lafayette

Segment	Description	Area (acres)	Area (km^2)	Volume (acre-feet)	Mean Depth (feet)	Mean Depth (meters)	Mixed Layer Depth (m)
A	Sinkhole	8.00	0.032	102.551	12.82	3.908	3.908
B	Main Body	103.05	0.417	217.95	2.11	0.645	0.645
C	Eastern Seg	27.34	0.111	28.811	1.05	0.321	0.321
D	NDD Trib	2.69	0.011	1.34	0.50	0.152	0.152

Meteorological Data

Precipitation data for Lake Lafayette was the same as used for the WMM and was acquired from the NCDC. The annual rainfall summation for 1998 was converted from inches to meters and used for the 1998 average simulation scenario. Table 5-26 shows the 1998 annual precipitation data.

Evaporation data was also acquired from the NCDC, but is only available for 9 locations within Florida. The closest location to Upper Lake Lafayette is Lake City, FL. Daily evaporation values from that station were used as surrogates for Upper Lake Lafayette. Blanks, out-of-limit values (-99999 or 99999), and 2-digit outliers (99) in the data set were replaced with linearly interpolated values. The resultant distribution of monthly pan evaporations for the Lake City station is shown in Figure 5-23. Lake evaporation values were then calculated by applying a factor of 0.7, which is a standard multiplier used for converting pan evaporation to lake evaporation. Table 5-26 shows the annual lake evaporation for 1998.

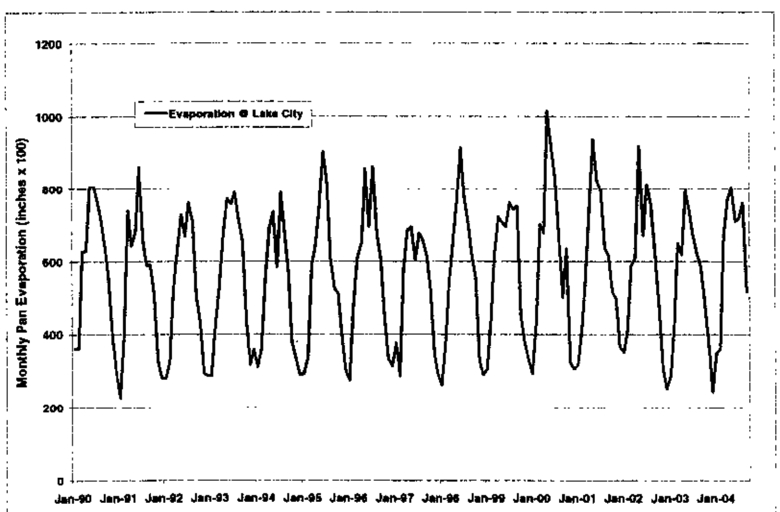

Figure 5-23. Monthly Pan Evaporation at the Lake City Monitoring Gauge

Table 5-26. Annual Precipitation and Evaporation used for the Upper Lake Lafayette BATHTUB Model

Year	**Precip (m/yr)**	EVAP (In/yr)	EVAP (m/yr)	**Lake EVAP (m/yr)**
1998	**1.49**	67.82	1.72	**1.21**

Measured Water Quality Data

The annual averages of measured TN, TP, and Chl-a from Upper Lake Lafayette (mostly sinkhole stations) were used for comparison of BATHTUB model results. These data were acquired from the IWR database. CV values for each parameter within each year are provided, along with the annual mean values and the calculated Trophic Status Index (TSI) values for each annual set, in Table 5-27. These TSI values are slightly different than the values recorded in the IWR database, since the IWR methodology involves calculating quarterly weighted values for Chl-a, TN, and TP and then determining the TSI based on the average of the quarterly weighted parameter values. The IWR does not report an average annual TSI value for years where quarterly data is missing. As a result, the only annual average TSI values in the IWR database are for 1996 (TSI = 48.27) and 1999 (61.04).

Table 5-27. Annual Means, Standard Errors, and Coefficients of Variance for Upper Lake Lafayette Chl-a, TN, and TP Measurements, 1996-2000. Corresponding TSI values are shown on the right.

Observation Year	Chl-a (ug/L)	Std Err (ug/L)	CV (%)	TN (mg/L)	Std Err (mg/L)	CV (%)	TP (mg/L)	Std Err (mg/L)	CV (%)	TSI
1996	13.03	5.33	40.9	0.755	0.164	21.7	0.114	0.028	24.9	**53.7**
1997	19.23	7.87	40.9	0.952	0.293	30.8	0.14	0.026	18.6	**59.0**
1998	63.58	14.95	23.5	2.088	0.368	17.6	0.184	0.017	9.4	**75.6**
1999	17.79	2.94	16.5	1.89	1.132	59.9	0.124	0.020	15.8	**64.1**
2000	7.48	1.23	16.4	0.594	0.085	14.3	0.103	0.026	25.2	**47.1**

Loading Data

Surface Runoff Loads – WMM nonpoint source load outputs for TP and TN are provided as input to the BATHTUB model. The outputs from subwatersheds N, D, and O are provided as input to the Northeast Drainage Ditch segment of the BATHTUB model. Output from subwatershed P is provided to the Main Body segment and subwatershed Q output is provided as input to the eastern segment of the BATHTUB model. Figures 5-24 and 5-25 show geographical representations of these subwatersheds and how they correlate to the Upper Lake Lafayette segments. The Buck Lake subwatershed (E), shown in figure 5-24, provides no loads to the system. Table 5-28 shows the WMM generated flows, TN and TP loads, and calculated

TN and TP concentrations provided as input to the BATHTUB model. These concentrations represent flow-weighted average for each year.

Table 5-28. WMM Generated Flows, Loads, and Calculated Concentrations Provided as Input to the BATHTUB Model (mg/m^3 units reflective of units used in BATHTUB model)

Subwatershed	1998 Flow (hm^3/yr)	1998 TN Load (kg/yr)	1998 TP Load (kg/yr)	1998 TN Conc (mg/m^3)	1998 TP Conc (mg/m^3)
NE Drainage Ditch	11.19	4369	2566	390	229
Lafayette Creek	1.58	670	332	425	211
Buck Lake Trib	0.00	0	0	--	--
NDD Trib Direct	0.14	29	24	214	177
Main Seg Direct	0.50	109	78	219	156
East Seg Direct	0.38	109	86	284	223

Atmospheric Loads – The BATHTUB model allows for the inclusion of atmospheric loads directly to the segments of the simulated water body. Atmospheric load inputs are entered as mass flux rates (mg/m^2-yr) and can be varied for each segment. Flux rates are determined as the product of the annual precipitation and the "effective" (i.e. wet + dry) rainfall concentrations for TN and TP. For this application, the effective TN and TP atmospheric concentrations were kept the same as those used for the existing draft Upper Lake Lafayette TMDL (0.392 mg/L for TN and 0.00625 mg/L for TP). Because no specific atmospheric information was available for the area immediately surrounding Upper Lake Lafayette, these values were calculated using data from a National Atmospheric Deposition Program study in Quincy, Florida and the National Urban Runoff Program study in Tampa Bay. The product of the atmospheric flux rate and the segment surface area establishes the atmospheric load for each parameter. Table 5-29 shows the atmospheric flux rates calculated for 1998.

Cyanobacteria Nitrogen-Fixed Loads – Table 5-27 shows that the average chlorophyll-a and TN concentrations observed during 1998 were significantly higher than the other four years. In fact, the TN concentrations observed in the lake exceeded the concentrations observed at the Weems Road station, just upstream of the lake, by multiples of 3 to 4. This indicates the presence of another source in the system during that year. Atmospheric TN concentrations are not expected to vary significantly from year to year and would have to be astronomical in order to make up the observed difference. One potential source that could increase both the in-lake concentrations of Chl-a and TN is cyanobacteria (or blue-green algae), which feed on excess phosphorus in a water body and "fix" atmospheric nitrogen, converting it into a soluble form that supplements the TN in the water column. Anecdotal evidence (McGlynn, 2004) has verified that cyanobacteria are occasionally present in Upper Lake Lafayette. The elevated chlorophyll-a concentrations observed during 1998 indicate that it was such a period.

Table 5-29. 1998 Upper Lake Lafayette Atmospheric Flux Rates for TN and TP

Year	Precip (m/yr)	TN Atm. Flux (mg/m^2-yr)	TP Atm. Flux (mg/m^2-yr)
1998	1.49	585.9	9.34

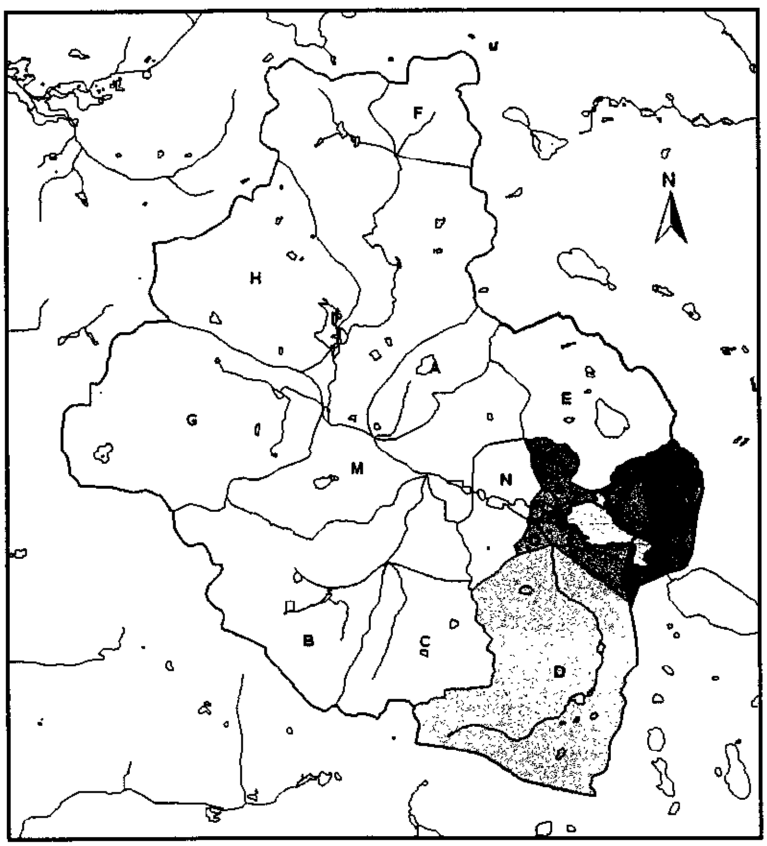

Figure 5-24. WMM Subwatershed Partitioning of Surface Runoff Loads to BATHTUB Segments. All Northeast Drainage Ditch subwatersheds (yellow) and Lafayette Creek (subwatershed D) have loads routed to the Northeast Drainage Ditch tributary segment of the BATHTUB model.

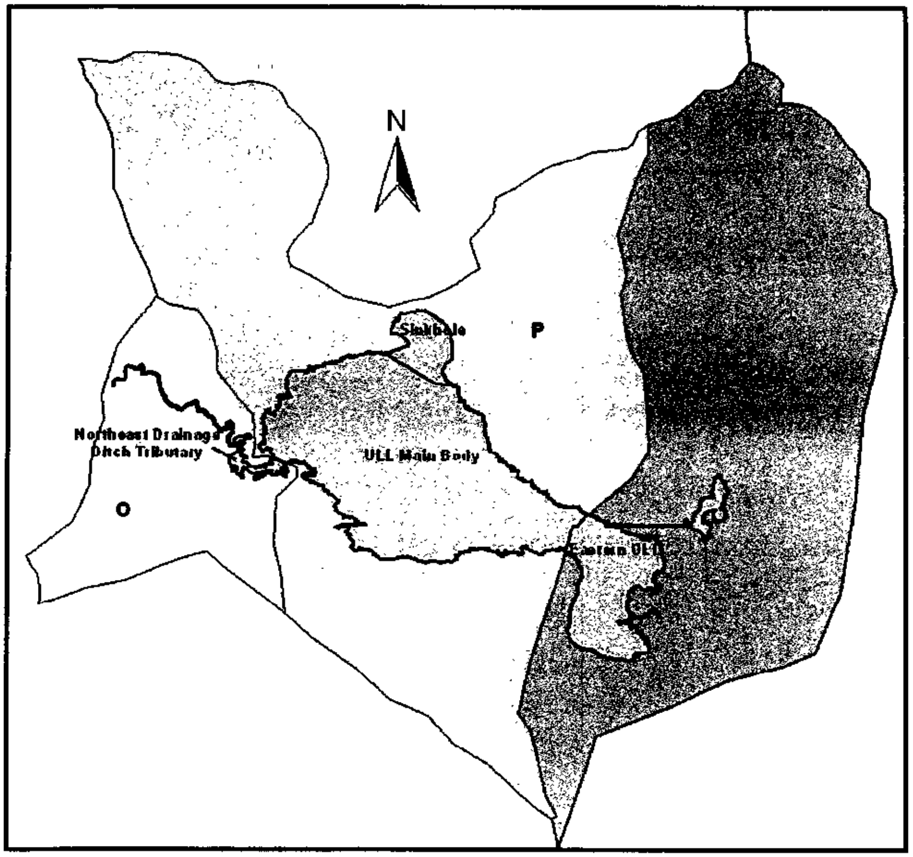

Figure 5-25. WMM Subwatersheds Providing Direct Runoff Loads to BATHTUB Segments. All of the runoff loads from subwatershed P are routed directly to the Main Body segment. No subwatershed loads are provided directly to the Sinkhole segment.

Calibration of the BATHTUB Model

Many of Florida's earlier TMDLs for nutrient-impaired lakes have used the integrated WMM-BATHTUB modeling approach. For most of those TMDLs, eutrophication in the subject lakes was a chronic condition, i.e. average annual TSI values were typically greater than 60. Table 5-27 shows that, for Upper Lake Lafayette, this is not the case, and eutrophication is more episodic. Based on Table 5-27, only 1998 and 1999 show average annual TSI values greater than 60 (it should also be noted that, for 1999, the average annual TN value of 1.89 mg/L includes a composite TN sample from 7/30/99 of 15.4 mg/L. Without that sample, the average annual TN value for 1999 would be 0.76 mg/L and the corresponding calculated TSI would be 56).

Since the eutrophication impairment in Upper Lake Lafayette is not chronic, and since 1998 is the only year of the verification period that consistently shows high nutrient and chlorophyll-a concentrations, the decision was made to calibrate the WMM and BATHTUB models to that year, rather than to the average condition of all years, as many of the previous WMM-BATHTUB applications were performed. This approach provides greater assurance that once the required nutrient load reductions have been established, the trophic status of Upper Lake Lafayette will remain at desired levels for any year. Conversely, nutrient load reductions implemented as a result of simulating the average condition would still allow for eutrophication to occur with a recurrence of 1998 meteorological conditions.

In addition, the specified 1998 lake elevation value of 34 feet was selected based on anecdotal information acquired from Leon County technical personnel and is not expected to remain consistent throughout the verification period. Therefore, calibration of the BATHTUB model for additional years at that lake elevation would be inappropriate. Unfortunately, measured Upper Lake Lafayette stage data was unavailable for this analysis.

To calibrate the BATHTUB model, each runoff source of TN and TP was designated as an independent "tributary". The five individual 1998 tributary flows and concentrations from Table 5-28 were input to the BATHTUB model. The 1998 atmospheric TN and TP fluxes from Table 5-29 were also input. Finally, the internal loading feature of the BATHTUB model was used to account for cyanobacteria nitrogen-fixed loading. This feature, which is frequently used to simulate septic tank loads, was not used for that purpose in this application, since the WMM model accounted for septic loads.

Internal loads are entered into the BATHTUB model as mass flux rates (mg/m^2-d). The process of establishing the cyanobacteria nitrogen loading rates was part of the calibration procedure. In order to determine the appropriate loading rates for each model segment, the 1998 TN runoff load (and resultant in-lake concentration) predicted for each model segment was compared with the equivalent average TN concentration observed during 1998. The difference in the simulated in-lake TN mass (simulated concentration X volume) and the observed in-lake TN mass (observed concentration X volume) was assumed to be coming from the cyanobacteria. For each model segment, the cyanobacteria mass flux rate was then determined by equation (1)

$$N_{cy} = [(M_{TNobs} - M_{TNsim}) * F_L] / [A_S * 365 \text{ d/yr}], \tag{1}$$

where N_{cy} is the cyanobacteria-derived nitrogen mass flux rate (mg/m^2-d), M_{TNobs} is the observed in-lake TN mass (mg), M_{TNsim} is the in-lake TN mass (mg) simulated by the BATHTUB model for runoff and atmospheric sources only, A_S is the surface area (m^2) of the segment, and F_L is the flushing rate of the lake ($year^{-1}$), which is also assumed to apply to each segment. Lake flushing rates are determined as the sum of the annual stream inflow and the annual net precipitation (i.e. precipitation less evaporation), divided by the volume of the lake. Table 5-30 shows the calculated Upper Lake Lafayette flushing rates for 1996-2000, assuming a constant volume of 431,324 m^3, defined at the 34 foot elevation contour. Table 5-31 shows the calculated 1998 cyanobacteria-derived nitrogen mass flux rates for each Upper Lake Lafayette segment.

Table 5-30. 1998 Upper Lake Lafayette Flushing Rates, assuming constant volume (431,324 m^3) and surface area (570,922 m^2)

Year	Inflow (m^3/year)	Precip (m/yr)	Precip (m^3/year)	EVAP (m/yr)	EVAP (m^3/year)	Flushing Rate (1/yr)
1998	12,857,000	1.49	850,674	1.21	690,816	30.18

Table 5-31. 1998 Nitrogen Mass Flux Rates for each Upper Lake Lafayette Segment

Segment	Description	Surface Area (m^2)	Flushing Rate (1/yr)	TN obs (mg/L)	TN obs (kg)	TN sim (mg/L)	TN sim (kg)	**Mass Flux (mg/m^2-d)**
A	Sinkhole	32,377	30.18	1.96	248	0.40	51	**503.1**
B	Main Body	417,038	30.18	1.96	527	0.40	108	**83.0**
C	Eastern Seg	110,630	30.18	1.96	70	0.40	14	**41.4**
D	NDD Trib	10,877	30.18	1.96	3	0.40	1	**19.6**

BATHTUB provides for the selection of various internal models to simulate the physical and chemical processes involved in lake eutrophication. Since the N/p ratio of observed TN and TP measurements in Upper Lake Lafayette indicate that both nutrients contribute to phytoplankton production in the lake, sedimentation algorithms for both nutrients were activated within the model. The settling velocity sedimentation option was chosen for both TN and TP in this study. This algorithm assumes a linear correlation of in-lake concentrations and sedimentation rates and also assumes an inverse correlation with depth of the lake, i.e. sedimentation occurs more slowly in deeper waters. The settling velocity option fits Upper Lake Lafayette conditions well, since the majority of the lake is relatively shallow (i.e. < 2 feet) and is expected to be well-mixed. Conversely, the sinkhole portion of the lake does offer an exception to this condition, with depths estimated between 40-50 feet. Thermal stratification is anticipated within the sinkhole, and the settling velocity sedimentation option would not be the preferred option for stratified waters. However, since internal algorithms are selected on a total domain basis, and not on a segment basis, the settling velocity option is expected to be a good selection for overall characterization of the lake.

The eutrophication response (i.e. chlorophyll-a) model selected for this application was the model option #1, which provides estimates of in-lake chlorophyll-a based on equations that consider TP, TN, light, and flushing. This option was chosen over the default option, which does not consider TN in estimating chlorophyll-a. Since observational TN data for Upper Lake Lafayette indicate nutrient co-limitation (and even some periods of nitrogen limitation), the effects of TN on Chl-a in the lake are considered to be important. Model option #1 attempts to account for the effects of nitrogen limitation on chlorophyll a levels. However, TN concentrations are predicted from the external nitrogen budget and do not account for potential fixation of atmospheric nitrogen by cyanobacteria. This is why the separate cyanobacteria nitrogen-fixed load was also simulated through use of the internal load option for each segment.

The default algorithms for transparency (i.e. secchi depth) and longitudinal dispersion were selected for the Upper Lake Lafayette application. The secchi depth algorithm (S = 1 / (non-algal turbidity + .025*Chl-a) is frequently applied and results in a calculated secchi depth of 0.5 meters for 1998. The average of observational data for 1998 is 0.56 meters. The longitudinal dispersion algorithm uses the Fischer et. al. dispersion equation, as adjusted for numeric dispersion.

Calibration factors were also applied to fit the TN, TP, and Chl-a predictions to the measured IWR data. BATHTUB allows for calibration factors to applied to either parameter decay rates or to concentrations. While decay rate calibrations generally assume that model-to-observation errors are primarily attributed to the sedimentation algorithm, concentration calibrations are more generic and do not make assumptions about the source of the error(s). Since the presence of cyanobacteria in Upper Lake Lafayette provides considerable interference to the nutrient balance and chlorophyll-a calculations, the concentration calibration option was chosen for this application. The calibration factors (0.88 for TP, 1.07 for TN) are well within the recommended ranges (0.33 – 3 for TP, 0.5 – 2 for TN) specified in the BATHTUB user's manual. A calibration factor of 0.78 was also applied for Chl-a. Results of model calibration are listed in Table 5-32.

Table 5-32. BATHTUB Calibration Results for Upper Lake Lafayette Application

Parameter (mg/m³)	Measured		Estimated		Percent	T Statistics		
	Mean	CV	Mean	CV	Error	T1	T2	T3
TP	188.0	0.05	187.1	0.45	**0.5%**	**0.10**	**0.02**	**0.01**
TN	1959.0	0.13	1956.5	0.55	**0.1%**	**0.01**	**0.01**	**0.00**
Chla	60.0	0.20	59.7	0.43	**0.5%**	**0.02**	**0.01**	**0.01**

The BATHTUB model provides statistical comparisons between observed and predicted concentrations. These are computed using three alternative measures of error: (1) observed error only, T1, (2) error typical of model development data set, T2, and (3) observed and predicted error, T3. Generally, absolute T2 and T3 values greater than 2 indicate a <5% chance that the chosen sedimentation algorithms accurately predict the sedimentation dynamics in the simulated lake. Absolute T1 values greater than 2 typically indicate that predicted concentrations have a <5% chance of agreeing with observed values. For the Upper Lake Lafayette model, the area-weighted, overall lake calibration results are all within 0.1, so for the assumption of a homogeneous well-mixed lake, predictions are well correlated with measurements and the model is considered to be calibrated properly.

Comparison of TSI values calculated from BATHTUB predictions with values based on measured data

Florida Trophic Status Index (TSI) values are calculated using the procedures outlined in section 3.0. For purposes of assessing TSI impairment, an "annual average" TSI is established by first determining the quarterly weighted averages of TN, TP, and CHLA concentrations. The annual TSI is then calculated using the quarterly weighted average concentrations. When data for any quarter within a calendar year is missing, the annual average TSI value is not determined within the IWR database.

Table 5-33 shows quarterly Upper Lake Lafayette TSI values calculated from IWR 1995 – 2000 database values of TN, TP, and CHLA. It should be noted that quarterly data is missing for 1995 Q1, 1997 Q4, 1998 Q1, and 2000 Q4. As such, the IWR database only lists annual average TSI values for 1996 and 1999. Table 5-33 also shows that TSIs calculated for each of the 1998 quarters are all above 70. The average of the three quarters is 73.87. Figure 5-25 shows the annual average TSIs calculated from this data, as well as the running quarterly average TSIs. This figure indicates that impairment conditions in Upper Lake Lafayette existed from the beginning of 1998 to the end of 1999. Additional data from 2001-2002 also shows other episodes of impairment.

The annual average TSI values for 1996 and 1999, as shown in Table 5-33, are between 5 and 10% higher than the respective IWR database values for those years. However, since the annual average TSI methodology establishes representative annual average values for the nutrient and Chl-a parameters, it also provides a way with which to compare observations with model results. Table 5-34 shows a comparison of the of the 1998 annual average TSI, calculated from IWR data, and the 1998 average annual TSI calculated from the calibrated BATHTUB output. The TSI values are the same.

Table 5-33. Quarterly, Annual, and Running Average TSI values for Upper Lake Lafayette, 1995 – 2000 (Data from IWR Database). Running average values in yellow are calculated with less than 4 consecutive quarters of data.

Quarter	Chl (ug/L)	TN (mg/L)	TP (mg/L)	TSI	Annual	Running
Q1 1995 Obs - averages						
Q2 1995 Obs - averages	31.15	1.403	0.013	**51.1**		**51.1**
Q3 1995 Obs - averages	30.90	0.944	0.014	**52.3**		**51.7**
Q4 1995 Obs - averages	18.40	0.221	0.139	**42.9**	**59.3**	**59.3**
Q1 1996 Obs - averages	20.60	0.679	0.218	**55.8**		**59.2**
Q2 1996 Obs - averages	2.70	0.028	0.028	6.8		**50.9**
Q3 1996 Obs - averages	35.55	0.749	0.170	**60.8**		**50.2**
Q4 1996 Obs - averages	6.86	1.062	0.088	**52.8**	**53.4**	**53.4**
Q1 1997 Obs - averages	8.05	0.354	0.198	**42.1**		**50.4**
Q2 1997 Obs - averages	6.18	1.098	0.147	**52.3**		**55.1**
Q3 1997 Obs - averages	42.92	1.452	0.103	**68.3**		**58.1**
Q4 1997 Obs - averages					**59.1**	**59.1**
Q1 1998 Obs - averages						**64.5**
Q2 1998 Obs - averages	47.15	1.507	0.200	**70.4**		**69.8**
Q3 1998 Obs - averages	48.60	1.957	0.197	**73.4**		**72.0**
Q4 1998 Obs - averages	84.03	2.414	0.167	**77.9**	**74.9**	**74.9**
Q1 1999 Obs - averages	20.80	0.871	0.115	**58.6**		**72.0**
Q2 1999 Obs - averages	16.49	0.533	0.190	**51.6**		**69.1**
Q3 1999 Obs - averages	21.80	4.737	0.099	**73.0**		**70.4**
Q4 1999 Obs - averages	13.61	1.170	0.083	**57.9**	**64.0**	**64.0**
Q1 2000 Obs - averages	7.73	0.870	0.178	**51.4**		**63.1**
Q2 2000 Obs - averages	5.64	0.562	0.040	**44.6**		**60.2**
Q3 2000 Obs - averages	10.37	0.447	0.120	**46.4**		**51.4**
Q4 2000 Obs - averages					**48.1**	**48.1**

Table 5-34. Comparison of TSIs Calculated from (a) quarterly weighted average annual measured values of Chla, TN, and TP and (b) calibrated BATHTUB output

TSI Calculation Method	Chl (ug/L)	TN (mg/L)	TP (mg/L)	TSI
Annual 1998 Equivalent	59.93	1.959	0.188	**74.9**
Bathtub 1998 Calibration	60	1.957	0.187	**74.9**

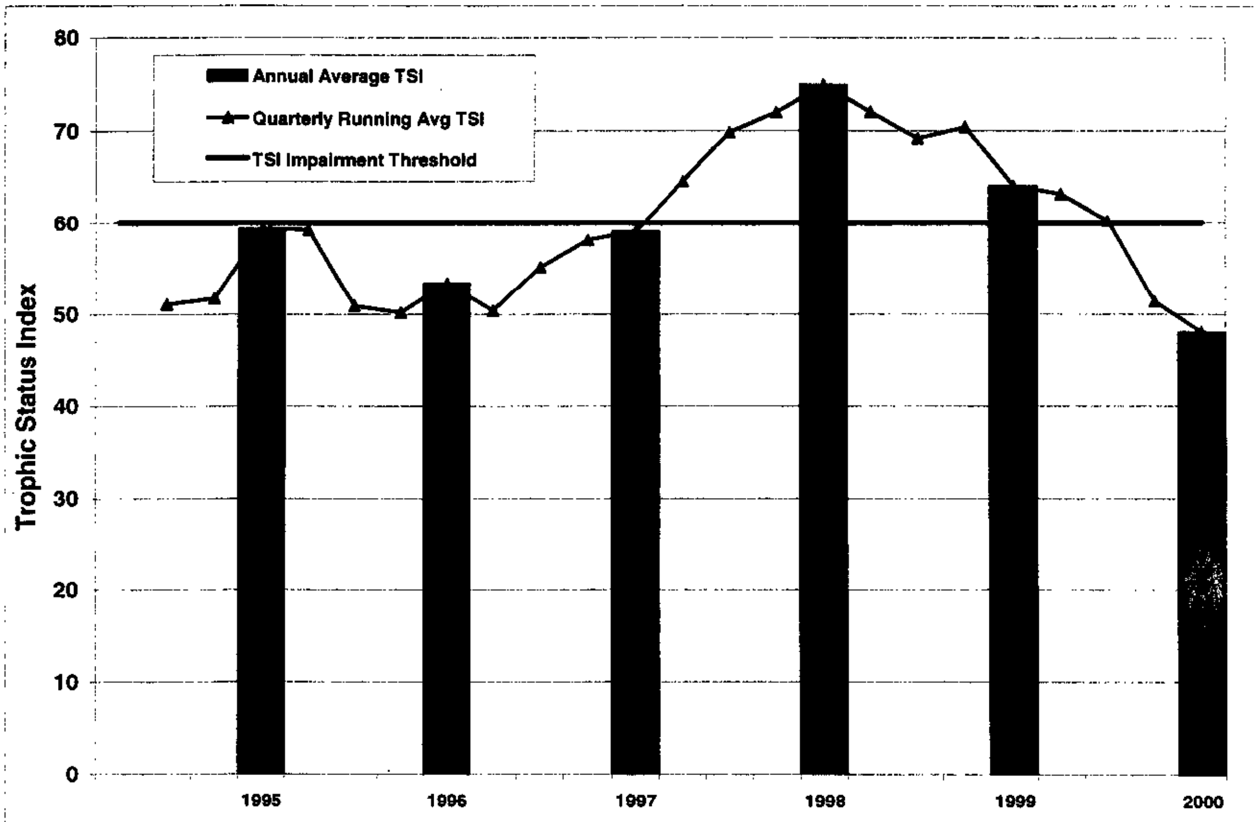

Figure 5-26. Upper Lake Lafayette Annual Average and Quarterly Running Average TSIs, 1995 – 2000.

Relationship between TP and TN loading reductions and predicted Upper Lake Lafayette TSI values

Using the calibrated BATHTUB model, alternative TP, TN, and Chla concentrations can be predicted for variations in TP and TN loads. The alternative concentrations can then be used to calculate predicted TSIs. Figure 5-25 shows how the predicted Upper Lake Lafayette TSI varies with (a) reductions in TP, and (b) reductions in TN, assuming a 60% reduction in TP has been achieved. According to Figure 5-25, a TSI of 60 could be achieved with either (1) an 80% reduction in TP loadings or (2) a 60% reduction in TP along with an approximate 57% reduction in all TN loadings (i.e. both runoff and internal loads).

Figure 5-27 shows the results of specific BATHTUB model scenario runs for Upper Lake Lafayette. For 60% reductions in both TP and TN, a resultant TSI of 58.7 is calculated. The corresponding in-lake "target" concentrations for TP and TN are 0.075 mg/L and 0.8 mg/L, respectively. These are the average annual in-lake concentrations that are expected to be protective of water quality for a repeat of 1998 conditions. Much of the 1998 simulated Upper Lake Lafayette TN load is due to internal sources (~80% from cyanobacteria nitrogen fixing). Although the dynamics of cyanobacteria growth in Upper Lake Lafayette is not well understood, the presence of the species has been verified. It is conceivable that most of the required TN reduction could be achieved through the control of phosphorus and the subsequent mitigation of algal blooms.

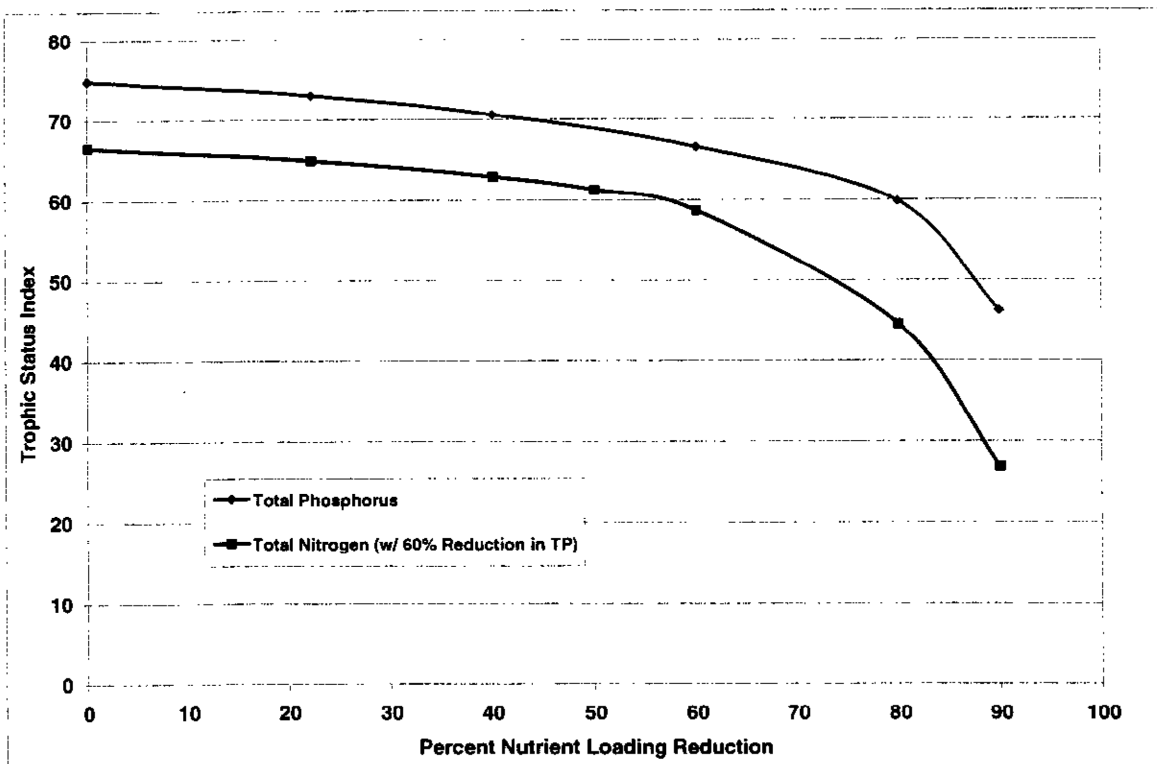

Figure 5-27. Relationships between Upper Lake Lafayette TSI and Nutrient Loading Reductions

Table 5-35. BATHTUB Model Nutrient Loading Reduction Simulations for Upper Lake Lafayette

Bathtub Scenario	Chl (ug/L)	TN (mg/L)	TP (mg/L)	TSI
1998 Calibration	60	1.957	0.187	**74.9**
P Reduction - 22%	54	1.957	0.146	**73.0**
P Reduction - 40%	46	1.957	0.112	**70.6**
P Reduction - 60%	34	1.957	0.075	**66.6**
60% P, N Reduction - 22%	32	1.531	0.075	**64.9**
60% P, N Reduction - 40%	29	1.184	0.075	**63.0**
60% P, N Reduction - 50%	26	0.992	0.075	**61.3**
60% P, N Reduction - 60%	21	0.798	0.075	**58.7**

Applying the in-lake "target" concentrations to the 1998 loads results in a TP reduction from 3087 kg/yr to 1235 kg/yr and a TN reduction from 25,555 kg/yr to 10,414 kg/yr. These load reductions are specific to the flow regime that occurred in 1998. Since the allowable loads to the lake would vary with inflows, TMDL goals should be kept as concentration-based, with the targets of 0.075 mg/L TP and 0.8 mg/L TN applying to all years.

In Table 5-35, the phosphorus reduction scenarios were modeled in BATHTUB without making corresponding reductions in internal nitrogen loading. Although it is anticipated that this internal nitrogen load attributed to nitrogen-fixing cyanobacteria would decrease as available phosphorus in the lake decreased, this cannot be quantified. Because of the unknown variability of the internal nitrogen and the relationship of the internal nitrogen loading to the overall TSI in the lake, at this time it is advisable to apply the in-lake target concentration for phosphorus only, with the understanding that corresponding nitrogen reductions may be sufficient to protect Upper Lake Lafayette and result in an acceptable TSI below 60.

6.0 DETERMINATION OF TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (Wasteload Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

As mentioned in Section 4.1, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$TMDL = \Sigma\ WLAs_{wastewater} + \Sigma\ WLAs_{NPDES\ Stormwater} + \Sigma\ LAs + MOS$$

It should be noted that the various components of the TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is accounted for within the LA, and b) TMDL components can be expressed in different terms [for example, the WLA for stormwater is typically expressed as a percent reduction and the WLA for wastewater is typically expressed as a mass per day].

WLAs for stormwater discharges are typically expressed as "percent reduction" because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges is also different than the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the "maximum extent practical" through the implementation of Best Management Practices.

This approach is consistent with federal regulations [40 CFR § 130.2(I)], which state that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. The TP nutrient TMDL for Upper Lake Lafayette (Table 6-1) is expressed in terms of kilograms per year and an associated percent reduction.

As mentioned previously, the IWR thresholds for nutrient impairment in lakes was used as the water quality target for the lake. Rule 62-303.352(1), FAC, specifies for lakes with an average color of 60 or greater that the annual average TSI should be 60 or less, unless paleolimnological information indicates the annual average natural TSI of the lake was greater than 60.

Table 6-1 TMDL Components

WBID	Parameter	WLA		LA (kg/year)	MOS	TMDL (kg/year)	Percent Reduction
		Wastewater (kg/year)	*NPDES Stormwater (Percent Reduction)*				
756A	TP	None	60%	1235	Implicit	1235	60

6.1 LOAD ALLOCATION

The allowable LA is 1235 kg/year for TP. This corresponds to reductions from the existing loadings of 60 percent for TP. At an annual average loading for TP of 1235 kg/year, the in-lake concentration of TP should be 0.075 mg/L. At this time, no LA for nitrogen is proposed, with the understanding that this LA and the corresponding reductions in phosphorus should decrease the internal and external nitrogen loading. These anticipated decreases may result in an acceptable TSI below 60. Subsequent monitoring of nitrogen concentrations at the inflow location and at the sinkhole monitoring site should be conducted in order to confirm this.

6.2 WASTELOAD ALLOCATION

6.2.1 NPDES STORMWATER DISCHARGES

As noted in Sections 4 and 6.1, load from stormwater discharges permitted under the NPDES Stormwater Program are placed in the WLA, rather than the LA. This includes loads from municipal separate storm sewer systems (MS4). The Upper Lake Lafayette watershed includes areas (Leon County and City of Tallahassee) that are permitted by the NPDES Phase I MS4 program, and the WLA for NPDES stormwater discharges is a 60 percent reduction of current TP loading from the MS4s, which is the same percent reduction that is required for all nonpoint sources. Any MS4 permittees are only responsible for reducing the loads associated with stormwater outfalls for which it owns or otherwise has responsible control, and are not responsible for reducing other nonpoint source loads within their jurisdictions.

6.2.2 NPDES WASTEWATER DISCHARGES

There are no known NPDES point source discharges within the subject watershed.

6.3 MARGIN OF SAFETY

An implicit margin of safety exists due to conservative assumptions used in the modeling process, and the use of a critical year (1998) for model calibration and subsequent application. In addition, the water quality data from the Weems Pond outflow was used in this study, with no consideration of nutrient uptake from the pond.

The absolute value of these loading numbers may be significantly different from the absolute loads calculated by other models, based on analysis using data from other sources, use of different assumptions, and/or differing interpretation of the results of other researchers. However, by using a critical year (1998), there is a high level of confidence that the load reductions required to return the lake to a healthy condition and the estimated concentrations of TP (0.075 mg/L) that would be expected in a healthy Upper Lake Lafayette.

7.0 NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

Following adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan for the overall St. Marks Basin. Development of this plan will be spearheaded by FDEP, although it is not yet certain how TMDLs not developed by FDEP will be incorporated into this process. The BMAP document will be developed in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished.

The Basin Management Action Plan (B-MAP), as described by FDEP, will include:

- Appropriate allocations among the affected parties.
- A description of the load reduction activities to be undertaken.
- Timetables for project implementation and completion.
- Funding mechanisms that may be utilized.
- Any applicable signed agreements.
- Local ordinances defining actions to be taken or prohibited.
- Local water quality standards, permits, or load limitation agreements.
- Monitoring and follow-up measures.

It should be noted that TMDL development and implementation is an iterative process, and this TMDL will be re-evaluated during the BMAP development process and subsequent Watershed Management cycles. While there is uncertainty associated with the nature of TMDL development and allocation, particularly in estimates of nonpoint source loads and allocations for NPDES stormwater discharges, these can be further refined or revised over time during reevaluation in the BMAP process.

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Appendix A

State and Federal Stormwater Programs

Appendix A

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, Florida Administrative Code (F.A.C.).

The rule requires Water Management Districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established section 402(p) as part of the Federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000 [which are better known as "municipal separate storm sewer systems" (MS4s)]. However, because the master drainage systems of most local governments in Florida are interconnected, EPA has implemented Phase 1 of the MS4 permitting program on a county-wide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the DOT (Department of Transportation) throughout the 15 counties meeting the population criteria.

An important difference between the federal and the state stormwater permitting programs is that the federal program covers both new and existing discharges while the state program focuses on new discharges. Additionally, Phase 2 of the NPDES stormwater permitting program will expand the need for these permits to construction sites between one and five acres, and to local governments with as few as 10,000 people. These revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that can not be easily collected and treated by a central treatment facility similar to other point sources of pollution, such as domestic and industrial wastewater discharges. The DEP recently accepted delegation from EPA for the stormwater part of the NPDES program. It should be noted that most MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

Appendix B

Leon County Data Processing

Appendix B
Leon County Land Use Data Processing

The aggregated land use coverage supplied to Applied Technology & Management, Inc for use in the Upper Lake Lafayette watershed modeling was created by aggregating parcel-specific property use codes from the Leon County Property Appraiser's NAL database (ebd\shape\property\parnal layer) into twelve broad categories based on the criteria used by CDM in the *Blueprint 2000 Capital Cascades Trail Land Use Matrix*. While the majority of codes were straightforward mappings, additional processing was necessary for the following categories:

1) Residential

Parcels with the property appraiser's NAL prop_use code 0100 were distributed between low, medium, and high density residential categories based on the acreage of the parcels.

> Low Density query selected for prop_use code = 0100 AND acreage >= 1.25 AND acreage <=3
>
> Medium Density residential query selected for prop_use code = 0100 AND acreage >= 0.333 AND acreage <= 1
>
> High Density residential query selected for prop_use code = 0100 AND acreage >= 0.1 AND acreage <= 0.25

2) Wetlands

Polygons from the Environmentally Sensitive Areas "wetlands" layer developed in 1999 (ebd\shape\esa\wetland) were superimposed on the existing land use categories. Where wetlands overlaid another land use category, the wetlands category replaced the previous category.

3) Water

Polygons from the 2001 "hydro" layer (ebd\shape\base01\hydro) with codes of :

210 River
212 Stream
215 Lake

were superimposed on the land use layer. Where water features overlaid another land use category, the water feature replaced the previous feature. Note that this means areas identified as open water types in 2001 will override wetland areas.

4) Roads

All remaining non-assigned areas are assumed to be roads (which are commonly not drawn as polygons in the property appraiser's layer). The results of all previous operations are unioned with the Leon County boundary and all polygons with NULL values were assigned to the roads land use category.

CAUTION
While this procedure makes and assumption that is in general reasonable, the results have not been checked comprehensively and it is likely that some areas may be assigned to the road category in error, thus areas of particular interest to the model should be verified by the user.

GIS DATA DISCLAIMER

Appendix C

Leon County Event Mean Concentrations

Table (iii)(B) - 1
Leon County EPA NPDES MS4 Part 2 Permit Application
Event Mean Concentrations and Impervious Percentages
Recommended for the Watershed Management Model (3), (4)

Land Use Category	Percent Imperv.	Oxygen Demand & Sediment (mg/L)					Nutrients (mg/L)					Heavy Metals (mg/L)				
		BOD	COD	TSS	TDS	SOURCE	TP	DP (1)	TKN (2)	NO23 (2)	SOURCE	Pb	Cu	Zn	Cd	SOURCE
1 Woods/Cleared	1.5%	1	51	11	100	A,B	0.05	0.03	0.95	0.3	A	0.000	0.000	0.000	0.000	B
2 Cultivated/Rural Agriculture	2.0%	4	51	55	100	A,B	0.34	0.23	1.76	0.56	A	0.000	0.000	0.000	0.000	B
3 Residential Preservation	2.0%	1	51	11	100	A,B	0.05	0.03	0.95	0.3	A	0.000	0.000	0.000	0.000	B
4 Urban Fringe	30.0%	9	65	59	59	C	0.45	0.27	1.77	0.27	C	0.013	0.007	0.057	0.001	C
5 Golf Course (5)	3.0%	4	51	55	100	A,B	0.34	0.23	1.76	0.56	A	0.000	0.000	0.000	0.000	B
6 Large Lot Residential	5.0%	6	58	16	165	E,F	0.19	0.12	1.08	0.42	E,F	0.001	0.003	0.016	0.001	E,F
7 Low Density Residential	15.0%	15	71	27	286	C	0.44	0.33	1.34	0.63	C	0.002	0.009	0.051	0.002	C
8 Medium Density Residential	25.0%	9	65	59	59	C	0.45	0.27	1.77	0.27	C	0.013	0.007	0.057	0.001	C
9 High Density Residential	50.0%	8	55	43	159	C	0.34	0.1	0.94	0.53	C	0.011	0.006	0.057	0.002	C
10 School/Institutional	55.0%	7	50	41	114	C	0.15	0.08	1.24	1.05	C	0.012	0.018	0.079	0.001	C
11 Commercial	85.0%	7	50	41	114	C	0.15	0.08	1.24	1.05	C	0.012	0.018	0.079	0.001	C
12 Waterbodies	100.0%	3	22	26	100	D	0.17	0.1	0.6	0.19	D	0.006	0.067	0.146	0.000	D
13 Mixed Use A	40.0%	10	61	47	121	G	0.36	0.23	1.52	0.57	G	0.010	0.011	0.062	0.001	G
13 Mixed Use B	65.0%	8	53	43	126	G,H	0.21	0.11	1.17	0.76	H	0.011	0.020	0.068	0.001	H

SOURCES:

A: "Estimation of Stormwater Loading Rate Parameters." Harvey H. Harper, 1992, Table 21.
B: Nationwide Urban Runoff Program (NURP), 1983.
C: NPDES Part II Stormwater Permit Applications for the Cities of Jacksonville, St. Petersburg, and Orlando, and the Counties of Palm Beach and Sarasota, 1992-93.
D: "Washington Metropolitan Area Urban Runoff Demonstration Project." Northern Virginia Planning District Commission, January 1983, Table 24.
E: Mean concentrations reported for wetland monitored as part of the Tampa NURP study for all constituents except TDS. TDS EMC was assumed from NURP data.
F: Large Lot EMCs were assumed to be 65% of Forest/Open and 35% of Low Density Residential land concentrations.
G: Mixed Use A EMCs were assumed to be 20% Low Density Residential, 50% Medium Density Residential, and 30% Commercial land use concentrations.
H: Mixed Use B EMCs were assumed to be 10% Medium Density Residential, 40% High Density Residential, and 50% Commercial land use concentrations.

NOTES:

1. Dissolved-P concentrations for Woods/Cleared, Residential Preservation and Waterbodies are generally 50% of the recommended total-P concentration (Harvey H. Harper, 1992 and Florida NPDES data, 1992-93).
2. TKN and NO_2 + NO_3 concentrations for the non-urban land use categories were assumed to be 76% and 24%, respectively, of the recommended total-N concentration (Florida NPDES data, 1992-93).
3. Averages reported are based upon parametric statistics with a lognormal distribution.
4. Concentrations reported below the detection limits were assumed to be 50% of the detection limits for the statistical analysis.
5. Golf courses were not explicitly included in the NPDES monitoring networks.

Appendix D

Water Quality Data

Appendix D

Water quality data available electronically